The Medical Epitome Series

HYGIENE AND PUBLIC HEALTH

PRICE

PEDERSEN

The Medical Epitome Series

HYGIENE

AND

PUBLIC HEALTH

BY

GEORGE M. PRICE, M.D.

Author of "A Handbook on Sanitation," "Tenement-house Inspection;" Inspector New York State Tenement Commission, 1894; *Medical Sanitary Inspector, New York Department of Health,* 1895-1904

SERIES EDITED BY

VICTOR C. PEDERSEN, A.M., M.D.

Attending Genito-urinary Surgeon to the People's Hospital; Deputy Surgeon to the Out-patient Department of the New York Hospital; Clinical Assistant in Dermatology, New York Polyclinic Medical School and Hospital

LEA & FEBIGER

PHILADELPHIA AND NEW YORK

AUTHOR'S PREFACE.

IN the following pages an attempt has been made to give an epitome of Hygiene and Public Health, a subject so vast and embracing so many correlated branches and sciences that the work of epitomization is especially difficult. Personal Hygiene has been entirely omitted, and some subjects of Public Health, upon which volumes have been written, have been disposed of in a few lines or a few pages. It has been the aim of the author to give the essential parts rather than to cover the whole field of the science. It is also obvious that it is impossible in a work of this kind to give all the sources from which the various parts have been taken, or to cite authorities at every step. References are given only where direct quotations are taken from other works.

I may add that I owe much to the kindly suggestions and coöperation of the Editor.

G. M. P.

EDITOR'S PREFACE.

IN arranging for the editorship of *The Medical Epitome Series* the publishers established a few simple conditions, namely, that the Series as a whole should embrace the entire realm of medicine; that the individual volumes should authoritatively cover their respective subjects in all essentials; and that the maximum of information, in letter-press and engravings, should be given for a minimum price. It was the belief of publishers and editor alike that brief works of high character would render valuable service not only to students, but also to practitioners who might wish to refresh or supplement their knowledge to date.

To the authors the editor extends his heartiest thanks for their excellent work. They have fully justified his choice in inviting them to undertake a kind of literary task which is always difficult—namely, the combination of brevity, clearness, and comprehensiveness. They have shown a consistent interest in the work and an earnest endeavor to coöperate with the editor throughout the undertaking. Joint effort of this sort ought to yield useful books, brief manuals as contradistinguished from mere compends.

V. C. P.

CONTENTS.

CHAPTER IV.

INDUSTRIAL HYGIENE.

CHAPTER V.

PUBLIC WATER SUPPLY.

CHAPTER VI.

FOOD SUPPLY.

CHAPTER VII.

MILK SUPPLY.

CHAPTER VIII.

Disposal of Waste Matter.

CHAPTER IX.

Public Nuisances.

CHAPTER X.

The Prevention of Infectious Diseases.

CHAPTER XI.

Federal Hygiene.

CHAPTER XII.

Sanitary Inspection.

HYGIENE AND PUBLIC HEALTH.[1]

CHAPTER I.

INTRODUCTION.

Hygiene is the science and the art, the theory and the practice, of the preservation and promotion of human health.

Public hygiene is the science and the art of the preservation and promotion of public health.

Personal hygiene is the science and the art of the preservation and promotion of individual health.

Sanitary science is the theoretical part of hygiene, notably that part which is based on the investigations of the influence of environmental conditions upon health and the study of the extrinsic causes of disease and premature death.

Sanitary art is the practice of public hygiene, the erection of public works for the improvement of public health.

Sanitation is the sum of practical measures undertaken for the preservation and promotion of public health.

Sanitary law, or "**public health law**," also called "**state medicine**," are terms applied to the rules, regulations, and laws prescribed by state or municipality as compulsory upon individuals or communities for the preservation and promotion of public health.

The **aim and function of hygiene** are the prevention of disease, the prevention of premature death, and the pro-

[1] The definitions, etc., are partly based upon Prof. Sedgwick's "Principles of Sanitary Science and Public Health." The statistics quoted in the latter part of the chapter are taken from Prof. Irving Fisher's "Report on National Vitality."

motion of normal health of individuals and the community by the removal of the causes of disease, destruction of the causes, improvement of environmental conditions, and by the increase of the vital resistance of individuals and members of communities.

The **aim and function of public hygiene** are the prevention of disease and premature death and the promotion of public health by the removal and destruction of environmental causes of disease and premature death and by improving such conditions as are common to many persons or communities.

Personal hygiene in aim and function is the preservation and promotion of individual health by the prophylaxis of constitutional diseases and by the increase of the vital forces and resistance of the human body.

The **scope and functions of sanitary science** are the study of the effects of environmental conditions upon public and personal health and the study of the causes of environmental diseases and the promotion of national vitality.

Hygiene as a modern science has entered the family of sciences only since the nineteenth century, and particularly since the establishment of sanitary science, vital statistics, and bacteriology.

The **origin of sanitation, sanitary art, and sanitary law** is as old as human society, and they date their history from the first common endeavors of social communities to preserve their health by framing rules for guidance in health matters, and by erection of communal sanitary works.

Great sanitary undertakings are seen in the ruins of Nineveh and Babylon; fine examples of wise sanitary precepts are found in the health codex of Moses; the Greeks had made great strides in the art of personal health promotion by their athletic exercises, baths, and gymnasia, etc., while the still extant ruins of the immense systems of drainage, the aqueducts, and public buildings of ancient Rome call forth the admiration of modern sanitary engineers.

But it is impossible to make people clean or healthy by religious precepts or state compulsory laws alone, or by the erection of great sanitary works, such as aqueducts, systems

of drainage, etc., without a preliminary education of the population in the importance of personal and public health and without a scientific basis for such an education.

Real **sanitary progress** has become possible only since sanitary science has shown the intimate relation of certain extrinsic factors to health, and since bacteriology found some of the causes of the most virulent diseases, and since we are able by the aid of vital statistics to prove the effects of sanitary improvement upon the health of communities and the reduction of disease and death rates by adherence to health laws.

Signs of sanitary progress manifest themselves in the following conditions:

(*a*) Lengthened span of life.

(*b*) Decreased mortality rate.

(*c*) Decreased morbidity from certain preventable diseases.

(*a*) The **length of the human span of life** has increased over 100 per cent. during the last several centuries, the greatest progress having been achieved during the nineteenth century.

During the sixteenth century the average span of life was but from eighteen to twenty years, during the eighteenth century it was a little over thirty years, while at the end of the nineteenth century it reached thirty-eight to forty years.

The average duration of life still differs in various lands; thus, while it was over fifty-two years in Sweden in 1891 to 1900, it was but a little over twenty-three years in India in 1901.

The increase and the general lengthening of human life were during the seventeenth and eighteenth centuries .	4 years
During the first seventy-five years of the nineteenth century	9 "
Present rate in Massachusetts	14 "
" " Europe	17 "
" " Prussia	27 "

(*b*) **Decreased mortality rate** is shown by the following:

Death rate (per 1000)	London	1680	50.0
" " "	"	1780	40.0
" " "	"	1905	15.1
" " "	Berlin	1751 to 1780	39.34
" " "	"	1841 to 1870	28.78
" " "	"	1871 to 1900	26.22
Urban American (white)		1804 to 1825	24.6
" " "		1826 to 1850	25.7
" " "		1864 to 1875	25.4
" " "		1876 to 1888	22.9
" " "		1889 to 1901	21.0
" "	New York	1886	25.99
		1908	16.52

(*c*) Only a few figures may be cited as proof of the considerable **decrease of mortality from certain preventable diseases:**

Typhoid Fever Mortality Reduced per 100,000.

Hamburg	from	39.7	in 1880–92	to	7.2	in 1894–99
Munich	from	291.0	in 1856	to	10.0	in 1887
Lawrence, Mass.	from	105.0	in 1892	to	22.0	in 1896

Smallpox Mortality Reduced per 100,000.

Prussia	from	24.4	in 1846–70	to	1.5	in 1875–86

Yellow Fever Mortality Reduced per 100,000.

Havana	from	300.5	in 1870	to	0	in 1901

The decrease of mortality from other diseases, like malaria, typhus, cholera, plague, etc., may also be shown by statistical data from various countries and for similar periods.

Further Possible Prevention of Disease.—According to the calculations of Professor Fisher, "the length of life could easily be increased from forty-five to sixty years, an elongation of fifteen years. This would result in a permanent reduction in the death rate of about 25 per cent. The principal reductions would come from the prevention of infantile diarrhea and enteritis (over 60 per cent.), bronchopneumonia (50 per cent.), meningitis (70 per cent.), typhoid fever (85 per cent.), tuberculosis (75 per cent.), deaths by violence (35 per cent.), pneumonia (45 per cent.), so that the estimate of

fifteen years as prolongation of life is a safe minimum without taking into account possible future discoveries in medicine or the cumulative influence of hygiene."

Economic Value of Human Life.—National health being the greatest national wealth and asset, it has been sought to calculate the economic value of human life and the financial loss through preventable deaths and diseases.

According to Fisher, "the average value of a person now living in the United States is $2900, and the average loss of a life sacrificed by preventable disease is $1700. As the number of preventable deaths is calculated to be about 630,000, the financial annual loss is 630,000 times $1700, or over $1,000,000,000."

Professor Fisher also calculates "that there are always about 3,000,000 persons in the United States on the sick list, of whom 1,000,000 are in the working periods of life, three-quarters of whom are actually workers and must lose at least $700 each annually, which makes a further loss of about $500,000,000, to which may be added $500,000,000 spent for medical attendance, drugs, etc., making a total loss of $1,000,000,000, about one-half of which is preventable; hence, the total loss by deaths and disease which are preventable amount to about $1,500,000,000 annually."

QUESTIONS.

What is hygiene?
Give definitions of public hygiene, personal hygiene.
Define sanitary science, art, sanitation, sanitary law.
What are the aim and functions of hygiene?
What are the aim and functions of public and personal hygiene?
State the scope and function of sanitary science.
Give example of ancient sanitary legislation.
State some of the ancient sanitary undertakings.
Since when do we date the progress of sanitary science?
In what does sanitary progress manifest itself?
Has the span of human life been lengthened? How much?
Has mortality rate been decreased? Give examples.
Has morbidity from special diseases been reduced? In what diseases and to what extent?
What are the further possibilities in disease prevention?
What is the economic value of human life?

CHAPTER II.

HOUSING HYGIENE.

Housing hygiene deals with the subjects of the relation of housing to health, and of the prevention of disease and promotion of health by improved construction, arrangement, and maintenance of human habitations.

Housing and Health.—A large part of human life is spent within doors, in houses, and any adverse conditions of housing will injuriously affect the health of the house-dwellers. Housing conditions are therefore important environmental factors influencing life and health.

The **dangers to individual health from housing** depend on the defects in construction, lighting, ventilation, heating, drainage, plumbing, and maintenance of the house.

The **influence of housing on public health** depends on the location of the houses in urban or rural localities, on the density and overcrowding of areas and houses, and on the sanitary regulation and supervision of housing construction and conditions by the community.

There is ample proof to show that location of houses in urban districts has an important influence on the mortality and morbidity of the house dwellers.

According to the census figures of the two last decennials the death rate of cities as compared with rural localities was:

1890	urban death rate per 1000	22.15	rural	15.34
1900	" " " "	18.6	"	15.4

The mortality from certain diseases is also greater in cities than in the country. This is especially the case with diseases like tuberculosis, pneumonia, diarrhea, etc. The mortality rate of tuberculosis was 204.8 per 100,000 in cities to 134 in the country.

The **influence of the density of population to the square mile or acre** was considered by older hygienists, notably Farr, as

seriously affecting the death rate, some statistical data having been brought forth to show that with a population of 3399 to the square mile the death rate was 26 per 1000, while with a population of 86 to the square mile there was a death rate of but 14 per 1000. There is a tendency by modern sanitarians to question the accuracy of the above figures, or, at least, the deductions from them. There is, however, no doubt but that extreme congestion of populations on given areas, and the overcrowding of people in streets, blocks, houses, and rooms, are followed by an increased mortality and morbidity. This has been shown by Dr. Anderson for Dundee, Dr. Olldendorf for Leipzig, Dr. Eberstadt for Mannheim, and the various Tenement House Committees for New York City.

The **increase of infantile mortality** in overcrowded sections and houses is a well-known fact in some districts in New York City, such mortality having reached the appalling rate of 205 per 1000.

The **influence of improved housing conditions upon health** has also been clearly shown in the reduction of the death rates in the cities owing to improved sanitary legislation and supervision within the last decades.

The decrease in morbidity and mortality rates in improved houses has been shown for the Octavia Hill houses in London, for certain model housing villages in Germany, and, but lately, for the model city of Bournville, in the urban district of Birmingham, where the death rate per 1000 for the last five years ending with 1907 was as follows:[1] Bournville, 6.3; Urban District, 10.3; Birmingham, 15.4.

BUILDING MATERIALS.

The **materials used for house construction** vary according to climate, geographical location, and physical character of the site. Among the materials used are wood, natural stone, artificial stone, brick, concrete, iron, and other metals.

[1] Barlow, Journal of the Royal Institute of Public Health, 1909, p. 105

Wood is the most extensively used material. It is strong, durable, easily obtained in most localities, and worked with comparatively little difficulty.

The objections against wood as a building material are that it is very absorbent, that it is inflammable, that it shrinks, and that it is subject to the actions of insects, moulds, and fungi, and to certain diseases, like dry rot, etc. As most of the diseases to which lumber is exposed are helped by dampness, wood is commonly made to undergo a process of "seasoning" before being used for building purposes, or it is impregnated with certain chemicals, like zinc chloride, copper sulphate, creosote, etc., to "preserve" it. Many kinds of wood are used for building purposes, from the native soft yellow pine to the exotic woods, like ebony, rosewood, etc.

Stone.—Natural stone is the strongest, most durable, and most beautiful material for house construction. The stone used varies in its quality, hardness, appearance, etc.

Brick is a semivitrified moulded clay, the quality of the brick depending on the chemical composition of the clay and the methods of its manufacture.

Brick absorbs considerable quantities of water. It is made in various shapes, and some bricks are made with enamelled surfaces.

Terra-cotta is made of certain clays, well baked, and is shaped in various forms according to need. It is a good fireproof or fire-resisting material, and is also used for ornamentation.

Limes and Cements.—Limes and cements are used for binding stones, bricks, etc.

Common lime is a product of the calcination of nearly pure carbonate of lime. It has a great avidity for water, evolving considerable heat during the process of absorption. On exposure to air, lime hardens by absorbing carbonic acid and forming carbonate of lime. Mixed with sand, lime forms mortar. Hydraulic lime is a lime which hardens under water, owing to the constituent aluminates and silicates in the lime.

Cements.—Portland cement is produced by subjecting a mixture of carbonate of lime to a calcinating process in special kilns and then reducing it to a fine powder.

Portland cement is slow in setting, sets under water, and when mixed with sand forms a strong mortar for use in all masonry work.

Concrete is cement mixed in certain proportions with sand and gravel, or small stones.

Natural cement (sometimes also called Rosendale or New York) is made of natural rock containing the right proportions of clay and carbonate of lime; the rock is broken, crushed, heated, ground, and pulverized.

Reinforced concrete is a concrete into which during the process of setting are embedded metal wires or bars, etc., to add strength.

Other materials used in house construction are the various metals—iron, steel, tin, brass, zinc, lead, copper—and the bitumens—asphalt, pitch, tar; also gypsum, asbestos, etc.

FIREPROOFING.

Fireproofing is a most important sanitary consideration in house construction in the prevention of fires, and of the loss of property and life consequent upon them.

There are **three methods of reducing the dangers from fires**—fireproof building materials, fireproof methods of construction, and appliances for escape during fires and for extinguishing fires. The term "fireproof" is misleading, as there are few materials which are absolutely fireproof or non-combustible. What is commonly meant by the term is a material more or less fire-resisting. Among the important fire-resisting building materials are the following: stone, iron, concrete, burnt terra-cotta, fire-clay, asbestos, mineral wool. The first three materials are but ignition-proof, but cannot resist high temperatures unless covered by the latter materials.

Fireproof construction consists in the elimination of wood, continuous air shafts, air wells, and hollow communications

between floors; the lining of all such absolutely indispensable openings with fire-resisting materials and providing them with metal self-closing doors; the construction of floors and ceiling of reinforced concrete and of metal columns protected by burnt terra-cotta; using asbestos or mineral wool for filling in openings in walls, floors, and other places, etc.

Fire Extinguishers.—The appliances for the putting out of fires consist in automatic water sprinklers, or the presence and provision of chemical fire-extinguishing apparatus, etc.

Fire Escapes.—The appliances for the speedy escape of dwellers during fires consist in the broadening of stairways, in the construction of fireproof stairways, in the provision of ample fire escapes made of iron, with suitable balconies, ladders, etc.

HOUSE DAMPNESS.

House Dampness and Health.—Dampness of houses, *i. e.*, the excessive moisture of the walls, floors, and ceilings of the house, and consequent increase in the relative humidity of the air in the rooms, are very prevalent in most houses; indeed, there are few houses which are free from such dampness.

The intimate relation of house dampness, especially when due to moist soils and sites, to health in general and to tuberculosis in particular, has been insisted on by older hygienists, notably, Bowditch, Buchanan, and Pettenkoffer.

The following is a **resume of the probable effects of dampness:**

Damp houses are cold houses, damp walls are cold walls, because damp walls and moist air are good conductors of heat.

Individuals lose more body heat in damp houses; more fuel is needed to warm such houses.

Damp houses favor chilling of the body surfaces, have a depressing effect on the human organism, and decrease its resisting powers.

Damp houses favor development of moulds, fungi, dry

rot and "haus-schwamm" in wood, efflorescence and saltpetering in masonry, and also favor insects and germ life within the house.

Damp houses cause the mildewing of clothes, injure furniture, produce spots on walls, make house cleaning difficult, heating expensive, interfere with ventilation, and decrease the suitability of the house as to comfort and shelter.

Damp houses may safely be regarded as predisposing causes of tuberculosis, bronchitis, pneumonia, nephritis, rheumatism, and other diseases.

The **causes of dampness in houses** may be due to conditions existing above the cellar, or to those in and under the cellar.

Dampness in houses above the cellars may be due to one of the following causes:

1. Porosity of building materials.
2. Water coming into contact with the walls and roofs.
3. Defects in construction and maintenance, such as defects in roof, leaders, and walls.
4. Occupation, uses, and abuses of house: the presence of persons, the heating and illumination, with the consequent production of aqueous vapor, the bathing, washing, and the like.
5. Capillary attraction from the ground.

Dampness of houses in or under the cellars is due to the entrance of water into the cellar from the following sources:

1. Surface waters from adjoining ground.
2. Subsoil water percolating through foundation.
3. Tidewater through ground or pipes.
4. Leaks in water-supply service pipes.
5. Leaks in plumbing fixtures or pipes.

Prevention of House Dampness.—The prevention of house dampness is best accomplished by removal of the causes of the dampness, and may be summed up as follows:

1. Selection of dry and well-drained sites.
2. Use of dry and well-seasoned building materials.
3. Thorough drying of newly constructed houses before occupation.

4. Careful use of water and steam within house.
5. Prevention of artificial sources of water in cellars.
6. Damp-proof method of house construction.

There are **three principal methods of damp-proof construction:**

1. Isolation by damp-proof courses.
2. Surface coating by damp-proof substances.
3. Incorporation of damp-proof compounds into materials.

Isolation by Damp-proof Courses.—The isolation of the building horizontally from the subsoil or vertically from the adjoining ground is accomplished by inserting in the foundations and into the walls a damp-proof material. Among the materials used for such *damp-proof courses* are the bitumens —asphalt and pitch—in the form of felt and papers impregnated with these materials and laid in several thicknesses coated with hot pitch. Other materials used for damp-proof courses are glass, slate, lead, etc.

As a damp-proof course for external walls some advocate the interposition of air, which, being a bad conductor, prevents the ingress of moisture into the inner wall; hence, the construction of hollow or double walls bound with non-absorbent ties or bonds. The objections to hollow walls are that they weaken the structure, and that the absorption and condensation of moisture instead of assisting dryness tends to keep the inner wall damp.

The **surface-coating methods of waterproofing** consist in the external application of waterproof paints, varnishes, asphalt cements, liquid bitumen compounds, etc., to the external walls, thus preventing the ingress of moisture through walls. A method known as "Silvester's" consists in washing off masonry walls with a solution of castile soap, then coating the wall with a solution of alum, which upon drying forms a water-repellant coating.

The **third method of damp-proofing** consists in the incorporation in the building materials, especially mortars, cement and brick, of certain waterproof materials, mostly of the bitumen class.

BUILDING CONSTRUCTION.

Aspect, Soil, and Site.—The importance of the site of the house cannot be overestimated, as on the site and its proper selection depend whether the house shall be healthy or unhealthy, dry or damp, cold or warm, etc.

The **aspect of the house** with relation to wind and sun is important in relation to insolation and dryness of the house.

The **relation of the soil to health** has been claimed by older hygienists to be of great importance, and it was believed that it bears a direct relation to the etiology of cholera, typhoid fever, tuberculosis, etc. While such claims may be regarded as exaggerated, it is nevertheless conceded that the character of the soil, its chemical composition, its hardness, the depth of the ground-water level, the fluctuation of said level, etc., play important roles in the sanitation of the house, and that the dryness, warmth, and comfort of a house depend on the kind of soil upon which it is situated.

When sites are water-logged, or when the ground-water level is above the height of the foundations, the water may be drained away by means of porous unglazed clay pipes in the subsoil, placed with a pitch toward a nearby watercourse, thus draining away the excess of water.

Foundations, Footings, and Cellars.—The foundation is the surface, or bed, on which the whole house rests; its preparation and proper treatment are of the utmost importance.

The **preparation of a foundation bed** is not difficult in clay or firm earth. An excavation, somewhat larger than the size of the house, is made, the loose soil removed, the place levelled, and the level surface covered with several inches of concrete, upon which surface the house then is constructed.

When the site is rocky the rock must be cleared away by blasting, and the foundation bed may then be prepared without a layer of concrete.

When the soil is water-logged, marshy, or consists of quicksand, or is entirely under water, the preparation of foundation is a difficult matter, as it is then necessary to resort to

the creation of an artificial foundation bed, which is accomplished by several methods, either by driving wooden piles into the soil, sawing off their tops and constructing the foundation upon these piles, or by sinking caissons, cofferdams, etc.

Once the foundation is prepared, the **footings,** or **base-courses of the walls,** are to be constructed of stone, or of concrete, to a thickness somewhat greater than that of the superimposing wall, and of a strength sufficient to bear the weights to be superimposed upon them.

A **cellar** is the lowermost story of the house, and must be well constructed, especially in regard to insolation of floor and walls from the adjoining ground by damp-proof courses in order to prevent the appearance of water in the cellar or dampness in the walls. Dry areas, several feet in width, around the cellar are necessary to insure dryness and light. Cellars must be at least eight feet high, should not be used for living purposes, and should be provided with ample windows and means of ventilation and warming, as the air from the cellar is being constantly drawn up into the rest of the house, and the air of the house will not be better than that of the cellar.

Walls, Floors, Roof, etc.—The methods of wall-construction depend on the material of which the walls are made. In frame construction the **security of the wall** depends on the timber-posts, sill, and plate, while in masonry construction the walls are made of stones joined by cement mortar, or of brick set in lime or cement mortar. In concrete construction the walls are made either of moulded blocks of concrete set in cement mortar, or of soft concrete poured into moulds and left to set and harden. Walls may also be made of concrete reinforced by steel rods, etc., embedded in the concrete, or the walls may be made of steel columns riveted together and covered with cement or terra-cotta.

The sanitary demands of **floor construction** are that the floors must be secure, and proof against air, dust, sound, heat, vermin, fire, and water. Unfortunately, floors rarely fulfil all these sanitary demands. The ordinary floors in houses are made of stout timbers, called joists, placed upon

edge at a fixed distance one from another, the upper surface of which is covered with wide boards nailed upon them, while the undersurface is furred, lathed, and plastered, and forms the ceiling of the lower room. As the space between the floor and ceiling is empty, the floor becomes a very good conductor of air, dust, heat, and sound, greatly assisting the spread of fire.

Modern floor construction demands that the floors be either solid, of reinforced concrete, or that the space within them be filled with mineral wool, asbestos, or that the floor be made of steel beams encased in terra-cotta, with interspaces made of reinforced concrete.

Roofs must be dust, sound, heat, fire, and waterproof. The materials of which roofs are made are straw, thatch, wood shingles, slate, tile, brick, glass, tin, iron, lead, tar, composition materials, etc. An air space between the roof and ceiling of the uppermost floor is necessary, to serve as a preventive against too rapid conduction of heat, etc.

HOUSE-PLAN AND ARRANGEMENT.

General House-plan and Arrangement.—Theoretically, every dwelling should be planned and arranged for the particular needs of the family which is to occupy the same. In practice such is seldom the case, and the house dwellers must adjust themselves to the already constructed house.

Special rooms are constructed for the special functions carried on within the house, such as cooking, sleeping, eating, entertaining, etc., as well as special rooms for each member of the family, especially for sleeping purposes.

In **internal construction the partitions** and **inner walls** are of importance, and the ordinary construction of the same of light timbers, with furring, lathing, and plastering, is reprehensible, as it renders them extremely combustible, and neither sound nor damp-proof. The substitution of metal framing and metal lathing is very desirable for partition construction as for external walls.

The **construction of halls, stairways,** and the **internal decorations** of walls and other parts of construction of the inner house are, of course, of the utmost importance. Stairways should be invariably of fire-resisting material, should be not too steep, with frequent changes in direction, and a rise of not more than six inches.

In modern construction the sharp corners and angles formed by ceiling and wall and wall and floor are eliminated by a rounding-up of these surfaces.

As a rule, the smoother the inner surfaces, and the less mouldings, projections, carving, and rough spaces within the house, the better. Inner walls should be so treated as to make them readily washable; therefore, papering walls and ceilings is objectionable, also because of the arsenical pigments so frequently found in them, and because of the fouling of the flour paste with which they are made to adhere to the wall. Some modern papers are made of composition, and are readily washable. Floors should be preferably of hard wood, or of tiling or cement. Kitchens, baths, and laundry rooms should have all surfaces hard and smooth, and damp-proof.

LIGHTING.

Natural Light.—Sunlight is essential for the growth of animal and vegetable life; it acts beneficially upon health, stimulates the metabolism of the body, assists in the oxygenation of the blood. Sunlight is also a powerful germicide and disinfectant; it kills low organisms, fungi, and moulds, is capable of destroying tubercle bacilli within a short time, and is therefore indispensable in human habitations. Habitations without direct sunlight are damp, cold, and unhealthy.

The **amount of natural light within a house** depends on:

1. Location and aspect of the house.
2. Sources of light.
3. Location and size of openings through which it penetrates.
4. Character of windows and of surfaces within the house.

Direct rays of the sun give more light than the reflected lights from adjacent surfaces, walls, trees, etc.

Greater light is obtained through horizontal openings on top of the house than from windows in vertical walls.

The **intensity of light within a house** depends on the character of the window glass, as there is a loss of light of 50 per cent. through milk glass, 10 per cent. through double glass, and 8 per cent. through plate glass. Prism or ribbed glass, by distributing and reflecting the rays of the light evenly through the room, increase its amount.

The **window area of a room** should not be less than 10 per cent. of the floor area; one square foot of glass surface thould be allowed for every 70 cubic feet of interior space to be lighted. Piers between windows should be narrow; window tops should extend to the ceiling, at least within 6 inches from same. Plate glass is best for transmission of light, unless prism glass is used. Smooth, light, or white colored surfaces of inner walls and floor and ceilings increase amount of reflected light.

Artificial illumination in the house is obtained by the raising of certain substances containing carbon to a degree of incandescence. Artificial illumination is obtained from electricity, or from oils, alcohols, water gas, coal gas, and acetylene gas.

The **value of artificial illumination** is judged by the following characteristics: intensity, quality, heat production, amount of impurities, safety, and cost.

Electric light may be very intense; ordinary incandescent bulbs are of 16 to 32 candle power; the newly introduced Tungsten lights give a more intense light at less cost.

Acetylene gas may give a very intense and brilliant light of from 20 to 160 candle power, while the intensity of other lights depends on their material, character of burners, etc.; Welsbach lights are made of mantles impregnated with earthy silicates, which become incandescent upon slight heating, giving from 60 to 120 candle power.

All illuminants, except electricity, produce much heat and

give off some impurities, such as CO, CO_2, sulphur compounds, ammonia compounds, smoke, soot, and moisture.

Acetylene gas (C_2H_2) is produced by mixing water with calcium carbide, during which process much heat is evolved. Special generators are manufactured for the production of the gas, and, contrary to the current opinion, there is little danger from explosions, as calcium carbide is not explosive either by heat or by concussion. The pipes used for ordinary gas illumination may also be used for acetylene lights, except that the tips of the burners must be smaller. The light is intense, steady, white, and cheap, and is very appropriate for houses in rural communities, or wherever there are no central plants for the manufacture of electricity or coal gas.

Coal gas is made by heating bituminous coal in air-tight vessels, during which process the combination of hydrogen and carbon are transformed into other gaseous and solid compounds. The refined products contain about 50 per cent. of hydrogen, 35 per cent. of marsh gas, 6 per cent. of CO, and residue.

Water gas is manufactured from anthracite coal, steam, and petroleum by a complicated process, the refined product containing 30 per cent. of CO, 35 per cent. of hydrogen, 20 per cent. marsh gas, and residue.

Because of the increased amount of CO, water gas is more dangerous to life and health than coal gas. The inhalation of even small amounts of water gas is injurious, while large amounts may become fatal by the carbon monoxide combining with the hemoglobin of the blood and forming an insoluble compound.

Coal gas and water gas are manufactured in central plants, from which they are conducted through iron tubes and pipes under the streets into the houses, and through a network of smaller iron pipes throughout the houses. The gas-service pipes are made of best wrought iron with malleable iron fittings, and the house-service should be provided with main and secondary stopcocks, and meters to measure the amount of gas consumed.

The gas-service system must be perfectly air-tight, should be exposed and readily accessible, and should be tested for air-tightness by appropriate tests before use.

Gas fixtures are of various shapes and value. The intensity of illumination greatly depends on the character of the burner. Argand and Welsbach burners are the best.

A too great intensity of light is controlled by shades and globes.

AIR.

The **atmospheric air** surrounding the earth is quite uniform in its composition. It contains oxygen, 20.94; nitrogen, 78.09; argon, 0.94; carbon dioxide, 0.03; with traces of helium, kryton, neon, xenon, and hydrogen (Haldane).

The most important of the **constituents of air** is oxygen, which is indispensable to combustion and breathing. The function of nitrogen, besides that of a diluent, seems to be to support certain forms of plant life; the use of argon is unknown; carbon dioxide is necessary to vegetable life, wherein the carbon is used for the carbohydrates.

Besides the foregoing components, air contains a larger or smaller percentage of moisture, and near the earth's surface it contains particles of dust and other impurities.

In densely populated towns the composition of air varies somewhat from the standard, in that the carbon dioxide may reach 0.04 or even 0.05 per cent., the amount of oxygen may be reduced to 20.87, while the number and quantities of various impurities may be very large, consisting, as they do, of the detrita of inorganic and organic life and products of combustion.

But, whether in country or town, the **natural constant diffusion of the air**, its constant motion due to winds, currents, and variations in pressure due to variations in temperatures, cause such a thorough mixing of the air that its approximate composition remains almost always constant, while the action of plants, producing oxygen and consuming carbon dioxide, equalizes the percentage of these two most important constituents.

House Air.—When, however, the air is shut up by walls, ceiling, and floor within houses, its composition naturally becomes different from the composition of external air, having become contaminated by the various impurities manufactured within the house.

The **sources of the impurities in air** are the following: (1) Respiration of persons; (2) illumination and heating; (3) accidental sources.

The **expired air from persons** differs in its composition from ordinary air by a decrease of oxygen (4 per cent.), increase of carbon dioxide (3.5 per cent.), and an excess of about 5 per cent. of aqueous vapor. There is also an increase in the temperature of the air, addition of some volatile matter, and, occasionally, some bacteria lodging in the nose, mouth, and throat may be dislodged and added to the expired air.

Artificial illumination and **heating** decrease the amount of oxygen, increase the amount of carbon dioxide, raise the temperature, add to the amount of aqueous vapors, and may also add products of faulty combustion—carbon dioxide, carbon monoxide, sulphur and ammonia compounds, etc.

Accidental Sources of Air Impurities.—Particles of inorganic and organic detrita, dust, etc., may also be added to the air from accidental causes, such as walls and surfaces of the house, processes carried on within the same, etc.

Relation of Impurities to Health.—While the increase of the percentage of aqueous vapor and the temperature of the room air may become of importance to health, the main danger to health of room air consists in the increase of carbon dioxide, respirable impurities and dust, deleterious gases, and bacteria.

The increase of carbon dioxide becomes of importance only when it reaches the infrequent amount of 4 per cent., provided this increase in the volume of the carbon dioxide is at the expense of oxygen; at 18 per cent. of carbon dioxide in the composition of air, with a corresponding reduction in volume of oxygen, death may follow rapidly. An extreme increase of carbon dioxide without a corresponding decrease in amount of oxygen is seldom taking place.

According to Rubner, the effects of the air of inhabited rooms are due to certain volatile carbon materials which have a biological influence upon health; according to others, it is due to the presence of expired "fatigue toxins;" while Flügge claims that it is due to the increased temperature of expired air. It is probable that the ill-smelling emanations from persons combined with the increase of carbon dioxide, decrease of oxygen, increase of temperature and aqueous vapor, all play a certain role in the bad effects of expired air upon human beings.

The dust in the air of rooms may be considerable and act as a mechanical irritant.

The number of bacteria in the air may be considerable, and some pathogenic microörganisms may adhere to the dust in the air.

VENTILATION.

Definition.—It is evident that with a number of persons present, and with illumination, combustion and other processes being carried on in a room, the added impurities in the air may soon reach such an amount that breathing may become difficult or dangerous on account of the added impurities. Unless, therefore, there is an influx of fresh air from the outside and removal of the impure air, the room air may become dangerous to health and life.

Such an exchange of air, the removal of inside impure air and its substitution by fresh, pure, outside air is called *ventilation.*

The **amount of pure air** needed to add in a room for each average person has been estimated as 3000 cubic feet, hence an hermetically closed room of 3000 cubic feet capacity, inhabited by one average person, will need an hourly change of air, while a smaller room will need a correspondingly more frequent change.

Spontaneous or Natural Ventilation.—Ventilation is carried on in ordinary houses spontaneously through the natural diffusion of the air through the porous walls and building

materials of the house, or the openings, cracks, crevices, etc., usually found in ordinary constructed houses.

Natural ventilation is also the exchange of air facilitated by making artificial openings in the house in the form of windows, transoms, skylights, or special openings in various places within the house.

Mechanical ventilation is that form of ventilation which is accomplished by a forced drawing out of the air from the house, or by a forced introduction of outside air into the house by mechanical means.

Not much dependence may be placed upon spontaneous, natural ventilation carried on through the porous building materials and accidental openings. With a great difference in the temperature of external and internal air there may be a certain rate in the exchange of air, but this is lessened by a more tight construction of the house, and by the modern methods of painting and water-proofing of houses.

The **principal means of ventilation** in most houses are the windows, doors, and the artificial openings especially made for the purpose.

The occasional opening of doors and the opening of windows greatly assist the exchange of air in ordinary dwellings with not too many persons in the rooms and with but ordinary illumination and heating.

When the number of persons in rooms is large and the number of lights increased, the windows and doors may not be sufficient for adequate ventilation, and special artificial openings may be needed.

The number and character of such openings vary in size, location, shape, character, etc.

The openings may be in the shape of tubes or boxes placed within the windows, the sashes, the panes, the walls, at different points, the ceilings, or the floors. All such openings communicate with the external air, and serve as air inlets, or outlets, and may also be provided with adjustable gates, so that they may be closed up when not wanted.

The number of ventilating devices is very large; their value depends on their location and size and character.

Where local heating is used within the house, ventilation is aided by the necessary chimney and flue openings, and by the use of grates and stoves.

Methods of Mechanical Ventilation.—The advantages of mechanical ventilation are the constancy of the exchange of air, the independence from any other means, the perfect control of the velocity and volume of the supplied air, the possibility to accurately regulate the temperature, quantity, moisture, and purity of the incoming air.

Mechanical ventilation is, as a rule, carried on from a central plant, and is of three kinds—*plenum*, or **propulsion method**, in which pure air is driven into the house from outside; *vacuum*, or **exhaustion method**, in which the impure air is withdrawn from the house; and the **combined vacuum** and **plenum methods**.

Mechanical ventilation requires motors (steam, water, or electrical) to operate the propulsion or exhaust fans, etc.; central ducts and tubes which radiate throughout the building, within or outside of walls, floors, etc.; and the inlet and outlet boxes or openings within the rooms.

Incoming air may be moistened, cooled, or warmed, and filtered in the central tubes; its velocity may be measured by anemometers, the temperature regulated by thermostats, and humidity controlled by humidostats.

HEATING.

While the human body may be accustomed to withstand great variations in the temperature of the external air, the range of temperatures of the air within houses which persons may withstand with impunity is rather limited.

A too high temperature in our dwellings interferes with the normal heat conduction and evaporation, while a too low temperature is dangerous by the withdrawal of the body heat in a greater rate than it is substituted.

Sudden changes in the temperature of the house may cause a sudden disturbance in the heat equilibrium of the body,

lower the resisting forces of the body, and predispose to certain diseases.

The proper regulation of the temperature within houses is therefore of the utmost importance to health.

The **proper temperature of rooms** must necessarily vary according to many factors, such as the season of the year, character of houses, strength and physical condition of individuals, habits, activity, etc.; but allowing for all the differences, it may safely be assumed that the maximum variations of temperature of rooms in houses for the average house dwellers should be in winter between 58° and 70° F., and in summer between 65° and 75° F., with a relative humidity of 40 to 50 per cent. in winter and 50 to 60 per cent. in summer.

It is obvious that the temperature of various rooms may somewhat vary; thus, a workroom may be lower in temperature than a sickroom, a bedroom lower than a living room, etc.

The hygienic demands on a system of heating rooms are as follows: Equable temperature, equable distribution, continuous heating, absence of impurities, proper degree of humidity, freedom from danger of fires, explosions, etc., and relative small cost.

Means and Methods of Heating.—Artificial heating of houses is accomplished by means of burning certain combustible materials within specially constructed receptacles.

The combustible materials, called fuels, are the following: Straw, cornstalks, dry peat, wood, bituminous coal, anthracite, coke, oil, alcohol, gas.

In the ordinary methods of combustion the various waste matters and products of combustion are removed through specially made flues and openings—the chimneys.

The quantity of waste products of combustion depends on the kind of fuel, intensity of heat, shape and character of receptacles, methods of heating, etc.

The smoke, gases, and other impurities of combustion processes may be lessened by improved methods of combustion and by various improved devices, like smoke consumers, etc.

There are **three methods of heating**—the radiant, the conductive, and the convective. The heat may be given off in direct rays from the combustible materials, as in grates, or may be conducted through some intermediate material, like iron, tile, etc., (stoves), or may be conveyed by means of air, water, or steam.

Heating may also be local or central; that is, the heat in rooms may be derived from the combustion carried on in receptacles in each room, or it may be conducted or conveyed from a central location within or outside of the house.

Local Heating.—The room to be heated contains a receptacle, or stove, in which the combustible material is placed, raising the temperature of the stove and the air surrounding it, and thus warming the room.

Local heating is accomplished by means of grates and stoves. Grates are the oldest form of heating, and are made of iron or tile open receptacles, in which the fuel is placed, which on combustion gives off direct rays to the surrounding air and objects, while the waste products are carried off through the chimney. It is a very wasteful method of heating, as 75 per cent. of the fuel is not utilized and is lost, the heat is not equally distributed, produces draughts and strong currents, and cannot adequately warm large rooms all over equally. Grate stoves greatly assist ventilation. The Galton form of grate is an improvement over the ordinary grate, in that the cold air from the outside is drawn into the grate, where it is warmed and returned to the room over a special opening, thus greatly aiding the ventilation of the room.

Stoves are made of iron, tile, brick, etc., and a larger percentage of fuel is utilized through them, as their heat is not only radiant, but is conducted by the iron, etc., of which the stoves are made. Stoves, however, waste a great deal of the fuel, are difficult to keep up continuously, produce ashes and dirt, necessitate the carrying of coal and fuel, and are otherwise cumbersome and inconvenient. When red hot, carbon dioxide and other gases may go through the stove.

Local heating by means of illuminating gas, or by means

of electricity, are preferable means of warming rooms, the only objection to them being their relatively greater cost.

Central Heating.—In central heating the combustion takes place not in the rooms to be warmed, but in a central location, within or outside of the house, from which central place the heat is conveyed by means of special pipes and flues to each room.

There are **three principal systems of central heating**—air, water, and steam.

Hot-air or **furnace heating** is very popular for small dwellings. It is cheap in its installation ($75 to $150 per house); The fuel is burned in a cast-iron combustion chamber located in the cellar; the combustion chamber is surrounded by an iron jacket containing air, which comes thereto from the outside through a cold-air flue or box; the heated air in the jacket is conducted through flues and pipes throughout the house, the pipes ending in each room by an opening called a "register," which may be opened or closed.

The advantages of hot-air heating are its simplicity and relatively small cost, while there are a number of grave objections to it, the principal ones being that the air is apt to become overheated and dry, that dust and smoke may gain entrance through registers and flues, etc.

Hot-water Heating.—This is regarded as the best form of central heating for small dwellings. Instead of an air jacket over the combustion chamber, there is provided a water receptacle, from which a continuous pipe ascends through the house to its uppermost part, whence it returns by a continuous descending pipe and connects with same water receptacle. The water being heated, circulates freely throughout the system of pipes and the radiators attached thereto, and by the heating of pipes and radiators warms the air of the rooms. Between the ascending and descending pipes there is usually placed an expansion tank to allow for the expansion of the water by heat.

This system of heating is simple, needs little attention, produces a pleasant and not too high temperature, is not subject to sudden variations, and consumes a relatively small amount of coal.

Steam Heating.—In this system the pipes are filled with steam instead of with hot water, and the water in the boiler is converted into steam. The temperature of the pipes and radiators is higher, their size correspondingly smaller, more fuel is needed to convert the water into steam, a higher pressure gained, more expert attention necessary, a greater degree as well as variation of heat reached. This system is especially suitable to large houses. Steam-heating plants may be located outside of the house and convey the heat by means of underground steam pipes.

WATER SUPPLY.

Water is needed for drinking purposes, also for preparation of food, for washing the body, clothes, etc.

The **amount of water** needed by men for all purposes varies according to many factors. Fifty gallons per day is a safe average minimum, while in large cities and civilized communities a supply of 300 gallons and more per person is not excessive.

Chemically pure water consists of two parts of hydrogen and one part of oxygen. But water is rarely in a pure state, as it is a very great solvent, and is commonly mixed with various foreign ingredients, some of which are harmless, while others may be deleterious. Water also contains gases like oxygen, carbonic acid, and various minerals.

The **most important foreign ingredients in water** are those of organic origin, such as microscopic plants, vegetable fungi, detritus of vegetable life, minute insects, infusoria, ova of insects, minute parasites, animal debris, products of organic decomposition, etc. The ammonia, nitrates, and nitrites frequently found in water are commonly due to results of organic decomposition. Water may also contain metals in solution, such as iron, lead, arsenic, copper, etc. Water usually contains millions of various microörganisms, mostly harmless, although at times it may also contain pathogenic germs.

"Hard" and "Soft" Water.—Water containing carbonate of lime is called **temporarily hard**, the carbonate of lime being driven off by boiling; when water contains the salts of magnesium, sulphates, and chlorides it is called **permanently hard,** as these salts are not removed by boiling. A water without those salts is called "**soft.**" A hard water precipitates its salts on boiling, prevents the softening of vegetables, prevents the formation of soap lather, hence a soft water is preferred for cooking and laundry purposes.

Good water should be clear, free from sediment and suspended matter, colorless, odorless, aërated, cool, soft, and palatable. Water must not be judged by one quality, and certainly not by its palatability, as a very palatable water may be contaminated with products of decomposition and owe its taste to the carbonic acid which is a result of decomposition.

Domestic Water Supply.—Water is derived for domestic supply from rain, from surface collections, and from springs and wells.

Rain water is soft and pure, unless it is contaminated by the surface air or by the receptacles in which it is collected. It is not palatable until it is well aërated. The quantity of rain water being variable and inconstant, no absolute reliance may be placed upon this source of water supply, although in rural places cisterns and tanks are commonly provided for the catching and storing of rain water.

Surface collections of water, in the form of lakes, ponds, and rivers, are a reliable means of water supply, but the water being exposed to contamination of organic decomposition, surface drainage, and sewage, such water may be dangerous to health.

Subsoil water is that which is gained from wells and springs. Springs are the outcroppings of deep underground water, and are, as a rule, pure and free from impurities, having gone great distances through the ground through which they filtered.

Shallow wells derive their water from surface drainage and the falling rain, and are often contaminated by surface sewage and products of organic decomposition.

Deep, driven, or bored wells, deriving their water from lower subsoil strata of underground water, are free from impurities, provided the wells are properly constructed, lined with non-absorbent material, are well covered, and are protected from surface contamination.

Domestic Water Purification.—Domestic water supply may be purified by sedimentation, boiling, distillation, chemicals, or by filtration.

By sedimentation it is possible to free the water from its mechanical impurities, sand, dirt, etc., without, however, much affecting matters held in solution.

By boiling, all organic matter and germs are destroyed; the taste of the water is, however, changed, owing to expulsion of gases.

By distillation a chemically pure water is gained, which may be made palatable by addition of carbonic acid.

By the addition of chemicals to suspicious water—small doses of borax, boracic acid, potassium permanganate, copper sulphate, etc.—the organic matter may be rendered harmless; but as those chemicals are not a desirable addition to water, this method of purification is objectionable.

In ordinary households the boiling of waters is a good precaution whenever the water supply is suspicious. Distillation, provided the proper apparata are at hand is the ideal method.

Water may be purified of all, or nearly all, of its impurities **by filtration**, the value of the process depending upon the medium of filtering, the efficiency of the filter, and the thoroughness of the process.

The materials used for filters are wool, asbestos, sand, stone, porcelain, infusorial earth, carbide of iron, charcoal, etc.

Infusorial earth pressed in the form of hollow tubes are used in the Berkefeld filters, which are efficient, although needing frequent cleansing. There are a number of other filters, quite efficient, provided they are frequently cleaned.

While some of the better filters may remove all impurities, even, it is claimed, all bacteria, from the water, this is seldom the case with filters after they are used for some time.

DRAINAGE AND PLUMBING.

The **average adult** excretes daily about three ounces of solid feces, and about 40 ounces of urine. This organic matter, if left exposed, soon decomposes and putrefies, and evolves bad odors. The excreta may also contain pathogenic germs capable of causing certain diseases. The keeping, therefore, of excreta within houses is dangerous to health, and its immediate disposal a sanitary necessity.

The **methods of immediate disposal of excreta** may be dry or by means of water. The dry methods are by means of pails, earth closets, and privy vaults; where there is a water service within the house the sewage may be disposed of through a system of pipes, the pipes carrying the diluted sewage outside into cesspool, privy, or into sewer.

The **pail system** is the simple expedient of gathering the sewage into water-tight pails, which are periodically removed from the house and emptied outside.

Earth closets resemble pails, of one or another shape, in which the excreta is mixed with earth, and the mixture removed with the closets, or through a system of wide pipes.

Privy vaults are excavations in the ground outside of the house, into which the excreta is voided and where it is left until the vault is full.

The objections against the pail and earth-closet systems are in the care they demand, the difficulty of keeping them clean, the need of frequent emptying, etc.

The objections against privy vaults are their proximity to the house, the putrefactive changes undergoing in them, evolving gases and foul odors, the dangers of flies carrying infection from them into the house, and the greater danger of contaminating the surface ground and polluting the sources of water supply.

The **water carriage disposal of sewage** consists in the installation of plumbing fixtures and pipes within the house from, which the sewage, diluted with water, is sent to cesspools, fields, or sewers.

A **cesspool** is a hole in the ground, similar to a vault, into which the liquid sewage and other liquids from the house are led by pipes from the house. It should be at some distance from the house, should be constructed water-tight, emptied periodically, or, better, be provided with automatically self-emptying siphon tanks to empty its contents at certain periods over the adjoining ground.

Field irrigation may be employed in conjunction with a cesspool, or independently of same. In intermittent irrigation the flushing tank is made to discharge its contents, at certain intervals, into a system of underground earthenware pipes, with open joints, the pipes being laid several feet under ground and radiating in various directions. The liquid sewage drains into the ground and is taken care of by the earth, which is enriched thereby. Large quantities of sewage may be disposed of with advantage upon fields by such methods, provided care is taken in the proper installation of the flushing tanks, and proper periods of rest are given to the fields to dispose of the organic matter.

House Plumbing.—A system of house-plumbing consists essentially of **three parts**—the fixtures, or receptacles into which the various household waste is dropped, the system of pipes leading from the fixtures throughout the house outside, and a system of water pipes feeding the plumbing fixtures and diluting the waste matter.

The **fixtures of house plumbing** are variously shaped according to their functions, and range from kitchen sink, laundry tubs, bath-tubs, washbasins, to water closets, urinals, etc. The best materials for making these fixtures are enamelled iron and porcelain, although cast iron, soapstone, and even wood have been used formerly.

The fixtures are connected by branches to the several vertical pipes running through the house, each serving a special function; thus, the "rain leader" runs outside of the house and collects the rain from the roof; the "waste pipe" runs vertically through the house and connects with all kitchen sinks and laundry tubs or washbasins, while the "soil pipe" is the main vertical pipe to which the water closets, and some-

times the bath tubs are connected. These vertical pipes run through the house and join in the cellar to the horizontal and inclined main pipe, called "house drain," into which all the various waste waters and sewage from all the fixtures and pipes are discharged. The house drain runs through the cellar and joins the street sewer by a short connection called "house sewer," which connects the house drain in front of the house with the sewer in the street.

All plumbing pipes, except the rain leader, which may be of sheet metal, are made of cast iron, with lead-calked joints. When wrought-iron pipes are used they are connected by screw joints. Short branch waste pipes may be of lead connected by solder wiped joints, but when connected with iron pipes are joined by means of brass screw ferrules, or fittings, calked into the iron and soldered to the lead.

The **admission of "sewer air,"** or **"sewer gas,"** as it is called, is prevented by means of the so-called "traps," which are bends in the pipes so constructed as to hold a certain amount of water, which acts as a barrier and prevents the foul air from the sewer side of the traps from coming into the house side of the traps.

In modern house plumbing there is usually one main trap on the house drain near the front wall inside of the house, this trap preventing air coming from the street sewer into the house, and, besides, every fixture within the house is separately trapped within two feet from the fixture, thus preventing the air from the pipes from entering the rooms through the fixtures.

Seals of Traps.—The traps are effective only while there is water within them, while the "seal," as the water within the trap is called, is intact; but there are a number of causes which unseal the trap.

Among the **causes of unsealing traps** are evaporation of the water through disuse, forcible ejection of seal through momentum and force of flush, or loss of seal through some waste paper, etc., being left in trap and emptying the water by capillary attraction.

The water in the trap of a fixture may also be lost some-

times by "siphonage," or by the action of a large column of water descending with great momentum down the vertical pipe with which the trapped fixture is connected, such force being sufficient to siphon out the seal, or contents of trap.

Fouling of the Seal.—The "seal," or contents of the trap, may also be fouled by constant and long contact with the foul air in the pipes, which foul air, owing to heat and decomposition within the pipes, is under increased pressure.

Protection against Loss of Seal.—Evaporation may be prevented by frequent use of the fixture, or by filling up the trap, when disused, by some non-evaporable fluid, like oil, etc., while the loss of seal by momentum and capillary attraction must be prevented by care in use of fixture and flushing apparatus.

To prevent the fouling of the seal by "back pressure," and its withdrawal by "siphonage," special "air pipes," or so-called "vent," or "back-air-pipes," are provided, which run through the house vertically, the same as the other pipes, and which are connected by branches to the crown of every trap of every fixture, and serve the sole purpose of preventing siphonage and back pressure.

The prevention of siphonage is accomplished by furnishing to each trap a column of air which may be drawn upon in lieu of the seal, while fouling of the water in the trap by back pressure is prevented by providing an escape of the air under pressure up into the vent pipes.

The vent pipes are made of cast iron.

Instead of providing vent pipes, there are sometimes provided so-called "non-siphoning traps," made and shaped so as to contain a large volume of water which may be difficult or impossible to empty by siphonage.

The **sizes of plumbing pipes** vary from 1½ inches in diameter of small branch waste pipes, to waste pipes, 3 inches; vent pipes, 2 to 3 inches; soil pipes, 4 to 5 inches; and house drains, 5 to 6 inches.

The whole plumbing system is ventilated by vertical pipes led through the roof and left open to the outside air, while

air from the outside is provided by means of the "fresh-air inlet," which, beginning with an air box in the sidewalk, runs into the house drain, inside of the main trap, by a 4-inch iron pipe. The vent pipes also aid the ventilation within the pipes.

The **water closet** is the most important fixture within the house. It should be made of porcelain in one piece, trap and fixture, with smooth surface and easily cleaned. The wash down, siphon, and "dececo" forms are the best.

Water closets are not flushed directly from the water service pipe for fear of contaminating the water supply, but are flushed indirectly through cisterns placed at least 4 feet above them, which cisterns are automatically filled and emptied by the pulling of a chain lifting a plug out of the socket and flushing through flush pipe into closet. There are several improvements upon this common method of flushing, one of them being the "Kenney flushometer," dispensing with the separate tank, at the same time preventing a direct connection with the water-supply pipes.

HOUSE CLEANING.

Dangers of House Impurities to Health.—The impurities which are found in houses are due to various sources, and may be divided in the following classes: household waste matter, waste water and sewage, gases and poisons, dirt and dust, organic matter, moulds and fungi, bacteria and micro-organisms, domestic animals, insects and parasites.

Household waste matters in the form of rags, cloths, rubbish, papers, etc., may become a nuisance in the house on account of the foul odors, of the organic decomposition upon them, by containing insects, parasites, and germs, and serving as vehicles for transmission of disease germs.

Waste waters, garbage, and **sewage** contain easily decomposed organic matter, breed insects and fouls odors, and are dangerous as vehicles of disease germs.

The gases which may occasionally be found in the house

are an excess of carbon dioxide and carbon monoxide from leakage of illuminating gas, smoke from chimneys, sulphur gases from decomposing products, sewer air, etc. Their danger to health need not be gone into here.

The **actual toxic elements** which may be found within the house are the poisons in the dirt, dust, air, and water, such as arsenic from the wall papers, lead from water pipes, etc.

The **dirt found in a house** consists of various substances and detrita of substances, inorganic and organic, which are either brought into the house from the outside upon the clothes, shoes, and bodies of persons, or which are blown into the house by wind through doors and windows; or the dirt may be due to processes carried on within the house.

House dirt and **dust** may consist of particles of soil, earth, brick, wood, plaster, hair, street dust, manure, ashes, excreta, dried sputum, pollen of flowers, pulverized fabrics, fungi, moulds, etc.

Dust is dried and pulverized dirt floating in the air, and its source is the same as that of dirt.

Dirt and dust may also contain particles from scales of the skin of persons suffering from smallpox, scarlet fever, measles, also of parasitic diseases. Dust may also contain some pathogenic microörganisms, as diphtheria, tubercle bacilli, etc.

The **dangers of dirt and dust to health** are self-evident. They may be mechanically irritant to eyes and the mucous membranes of nose and throat, and through the pathogenic germs may be causative of certain infectious diseases.

Organic matter, moulds, and **fungi** are abundant in houses, especially where there is considerable dampness; some of the fungi, such as those of "haus-schwamm," and "dry rot," may be irritants to the respiratory tracts.

The **bacteria** and **microörganisms** in general which may be found in houses are very numerous and of varying importance, according to their virulence. They may cling to the dust floating in the room air, or they may cling to the various dirt, insects, animals, and matter in the house

Domestic Animals and Health.—Dogs, cats, birds, etc., may become a source of danger to health by their excreta, by the diseases from which they may suffer, by the parasites which they may carry, and by the pathogenic germs which they may transmit.

House Vermin and Health.—Though not exactly domestic animals, rats are almost always uninvited inhabitants of most houses, and may play an important role in the transmission of certain diseases, like plague, with which their connection had been clearly proved, and which they may transmit either directly by their bites, or indirectly through fleas, lice, and other parasites upon them.

Houses may be teeming with **various parasites** and insects, such as roaches, beetles, centipedes, spiders, waterbugs, flies, fleas, lice, bed-bugs, and mosquitoes.

The very presence of some of the insects named is a nuisance because of their appearance, odor, or bites. Some of these insects feed either upon their human hosts, or upon domestic animals, or upon the food of their hosts. The bites of some of the insects may become fatal when they are infected with some disease germs like plague, etc. They may also be carriers of infective germs upon their bodies, legs, and wings, and may cause infection directly or indirectly.

Flies as propagators of typhoid fever in their travel between privy vaults, manure heaps and the water, milk, and food upon which they swarm are well-known offenders, and there is reason for the opinion expressed by some that they may also spread tubercle bacilli from patients and their sputa to articles of food.

The role of the **mosquito as an intermediate host** of the germ of malaria and yellow fever is spoken of in another place, and the presence of these insects within houses may become a menace to the life and health of house dwellers.

Prophylaxis.—The warfare waged by house dwellers against all the forms of dirt enumerated must be constant, interminable, thorough, and remorseless.

The **methods of prophylaxis** consist in the prevention of

ingress and accumulation, removal by cleaning, and destruction by cremation and disinfection.

Waste matter, rubbish, garbage, etc., may be prevented by prompt cremation of all such matter, by collection in tight receptacles, and by frequent periodical municipal removal.

Waste water and sewage are made harmless by disposing through plumbing fixtures and pipes.

Proper care of the illuminating and heating plants and ample ventilation will prevent the dangers of gases.

The non-use of arsenical papers and lead paints, or lead pipes, will prevent these poisons in the air and water.

Dirt and dust in houses may be prevented by proper tight construction of windows and doors and provision of some other protected openings for ventilation, by thorough cleansing of shoes and cloth before entering the house, by elimination of any projections, mouldings, nooks, and corners within the rooms, and by provision for the dryness and perfect lighting of all parts of the house.

Fungi and moulds may be prevented by preventing dampness and darkness in any part of the house.

Domestic animals should not be kept within the house, or, if kept, should be daily attended to, examined for symptoms of disease, frequently washed, cleaned, and disinfected, and prevented from depositing their own excreta within the house, or bringing in any from outside of the house.

The presence of insects within the house may be partly prevented by thorough cleanliness, by absence of darkness and dampness, by screening windows, doors, and other openings, by covering with wire nets any and all edible materials, by spreading borax or boracic acid mixed with sugar, or by destroying them by arsenic, formaldehyde, or sulphur disinfection and fumigation.

Destruction of rats is a difficult matter, and may perhaps be accomplished by proper vermin-proof construction of houses, houses without hollow spaces and places for their habitat. Fumigation, poisoning, and such means may prove valuable.

The prevention of the incoming of the fly and mosquito consists, besides the above numerated measures, also in the

thorough sanitation of the surrounding grounds and area of houses, and destruction of breeding places of those insects.

Means and Methods of Cleaning.—The common methods of house cleaning are wrong in principle and faulty in practice. The **dry method** of cleaning by means of raising the dirt and dust by feather duster and dusting rags is worse than letting the dirt and dust lie undisturbed. Nor is the common method of cleaning floors, etc., by spilling water upon them an improvement upon the dry method.

The ideal method of cleaning is the **modern suction** or **vacuum process** by means of special apparata operated by motors driven by steam or electricty. Some of these vacuum cleaners are made so as to be operated by hand, but are not so satisfactory.

Damp-cloth Method.—Apart from the vacuum cleaners, the best method of removing dust from walls, furniture, etc., is by means of damp rags applied to all surfaces, said rags then being washed and boiled in water.

Some surfaces, such as walls, furniture, metal beds, etc., may advantageously be wiped off with such cloths or rags dampened in solutions of from 3 to 5 per cent. of carbolic acid, corrosive sublimate 1 to 5000, or formalin 5 per cent.

Curtains, carpets, rugs, and similar soft stuffs should be removed from the house before cleaning, and be subjected to boiling or steaming.

Wooden floors, furniture, wainscoting, etc., in houses may be cleansed by a cloth dampened with kerosene oil, and then polished with other oil-impregnated cloths.

Stone, tile, and mosaic floors may be scrubbed with hot soap-suds and wiped off with cloths impregnated with carbolic acid.

Evaporation of formalin or formaldehyde may advantageously be used in clothes closets. attics, etc., while fumigation with sulphur, if properly done, will destroy all insects and parasites.

Disinfection by chemical or gaseous means, as described in the chapter on "Disinfection," should be practised in houses at stated and frequent intervals.

THE HOUSING PROBLEM.

The "housing problem," the "housing question," the "housing of the workingman," or "the tenement-house problem" are terms variously applied to the same sanitary-social-economic housing problem, which is one of the burning questions of the age.

In its final analysis the **housing problem essentially consists in** the difference between housing conditions as they *are* and housing conditions as they *should be* according to the precepts of housing hygiene.

The housing question has become a problem only since housing hygiene has been scientifically established, when sanitarians have studied the effects of defective housing conditions upon individual and public health, when rules have been laid down for the proper sanitary construction and arrangements of human habitations so as to influence health beneficially instead of injuriously as heretofore.

Briefly stated, the housing problem consists in the following defective housing conditions, and the task of removing such conditions and providing the majority of the population with sanitary dwellings.

The **defective conditions in housing** are as follows: Too great density of population upon given areas; overcrowding in cities, streets, blocks, houses, and rooms; damp, water-logged, filled-in sites; defective, flimsy, speculative, and cheap construction; absence of damp-proof insolation and water-proofing; non-fire-proof construction; absence of fire-protective appliances; defective construction of walls, floors, roofs, etc.; improper arrangement of rooms; insufficient window space, absence of windows and openings for light; defective plants, fixtures, and pipes for artificial illumination; deficient provision for adequate ventilation; faulty methods and plants for heating; defective installation of plumbing fixtures and pipes; absence of provision for cleaning; presence of dirt, dust, insects, and germs. The above are some of the conditions commonly found in houses of the poor.

The concentration of such houses in certain well-defined sections of cities; the congestion of populations in tenement houses in special insanitary overcrowded districts; the increased adult death rate, large percentage of mortality from infectious disases, and an appalling infantile rate of mortality are some of the concomitant conditions of the housing problem.

The analysis of the **causes of faulty housing-conditions** is within the province of the social-economist rather than that of the sanitarian, the purpose of the latter being but that of showing up the sanitary defects as they are found, noting their effects upon individual and public health, and devising means for improved sanitary construction and conditions in housing.

The **remedies for faulty housing conditions** proposed by the social-economists are many and various; the remedies proposed by the sanitarians are briefly enumerated as follows: Sanitary supervision of housing conditions; sanitary inspection of existing houses; compulsion of owners to remedy defects and keep houses in sanitary condition; legislation restricting improper use of building areas and demanding the construction of houses in the future according to fast-laid-down laws based upon housing hygiene; the destruction of insanitary areas, demolition of insanitary houses, and a complete supervision by proper expert qualified authorities of all housing construction in the future, as well as existing houses at present.

QUESTIONS.

Give definition of housing hygiene.
What are the relations of housing to health?
What are the influences of urban location of houses?
What are the influences of density of population?
Give examples of relation of density of population to infant mortality.
State the influence of improved housing conditions.
What materials are used for house construction?
What are the advantages and disadvantages of wood?
What are the advantages and disadvantages of stone, brick, iron?
What is lime, terra cotta, portland cement, concrete?
What is natural cement, reinforced concrete?
Enumerate fire-resisting building materials.
What does "fire-proof" construction mean?
What are the appliances for fire-escape, for fire extinguishing?
State what harm to health there is in damp houses.
What are the causes of house dampness?
What are the causes of wet cellars?
What are the best means for preventing dampness in houses?
What are the three principal methods of fire-proof construction?
What are the relations of the site, soil, and aspect to health?

What are footings, and how constructed?
How should cellars be constructed?
What are the methods of wall construction?
What are the sanitary demands upon floor construction?
State the proper construction of roofs.
What are the sanitary requirements of proper inner construction?
What is the relation of sunlight to health?
Upon what does the amount of natural light in houses depend?
What should be the window area?
What are the sanitary requirements of artificial illumination?
What is acetylene gas, how produced?
What is the difference between coal and water gas?
What are the sanitary requirements of gas illumination?
Give the composition of atmospheric air.
What are the variations of O and CO_2?
What are the sources of house impurities in air?
What is the relation of increase in CO_2 and deterioration of air?
What is ventilation, and why necessary?
What is the quantity of air needed for person per hour?
What is natural, artificial, and mechanical ventilation?
What are the principal means of natural ventilation?
What are means of artificial ventilation?
What are the relations of heating to ventilation?
What are the advantages of mechanical ventilation?
What are the effects of a too high or a too low temperature?
What are the effects of a too sudden change in temperatures?
What is proper temperature of rooms?
What are the hygienic demands from a system of house heating?
What are the three methods of heating?
What are the objections to local heating?
What are the advantages of central heating?
Name the principal systems of central heating.
What are the advantages and disadvantages of furnace heating?
What are the advantages and disadvantages of hot-water heating?
What are the advantages and disadvantages of steam heating?
What are impurities commonly found in water?
What do we mean by "hard" and "soft" water?
What are the sources of domestic water supply?
What are the objections to each of them?
What are the common means of domestic water purification?
Name the methods of sewage disposal.
What are the objections to the dry system of disposal of sewage?
Describe a privy-vault and state objections to it.
What is a cesspool and what are the objections to it?
Describe a system of field irrigation
Wherein does a system of house plumbing consist?
What are the materials of house plumbing fixtures and pipes?
What is sewer air and how prevented in houses?
What are the causes of loss of "seal" in traps?
How is it prevented?
How is the plumbing system ventilated?
How are water closets flushed?
Name the various impurities found in houses.
What are the dangers of dust, dirt, and organic matter?
What are the dangers of domestic animals and insects in houses?
What are the methods of prophylaxis against those dangers?
What are the common methods of house cleaning?
What are proper methods of house cleaning?
What is meant by the "housing problem"?
What are the remedies commonly advocated for its solution?

CHAPTER III.

SCHOOL HYGIENE.

RELATION OF SCHOOLS AND SCHOOL LIFE TO HEALTH.

Scope of School Hygiene.—School hygiene is that branch of public hygiene dealing with the effects of schools and school life upon health, the causes of such effects, and the means to preserve and promote the health of the school children, and hence the public health.

There are in the United States nearly 18,000,000 school children between the ages of six and eighteen who are subject to the influences of schools and school life during a large part of the day and a greater apart of the year, and during a period of life when, by reason of undeveloped physical and mental faculties they are peculiarly influenced by any and all environmental conditions in which they are compelled to live.

The **ill effects of school life on the health of children** manifest themselves in the following ways:

1. Defective development of the child.
2. Retardation of growth.
3. Actual physical defects developed by school life.
4. Special "school diseases."
5. Defective mental development.

There are ample statistical data to prove the **defective physical development** of a large percentage of the school children, defects in a great part due to school influences.

According to the investigations of Danish, Swedish, and Norwegian authorities it was found that the percentage of physically defective children were as follows:

	Boys. Per cent.	Girls Per cent
Kopenhagen (Hertel)	31.1	39.4
Danish Commission	29.0	41.0
Sweden (Key)	34.4	61.7
Norwegian Commission	21.9	36.6

According to an investigation undertaken in Washington, D. C., during 1908, by the "Presidents' Homes Commission," it was found that out of 43,005 pupils (29,598 white and 13,407 colored) there were 15,304 defectives, or 35.5 per cent.

According to an examination undertaken by the inspectors of the New York City Department of Health in 1906, out of 100,000 examined children there was 66 per cent. physical defectives.

The following detailed report of the examination by this Department of 78,401 children is of extreme interest:

		Per cent.
Number examined	78,401	100.0
Total number needing treatment	56,259	71.7
Bad nutrition	4,921	6.3
Anterior cervical glands	29,177	37.2
Posterior cervical glands	8,664	11.0
Chorea	1,380	1.7
Cardiac disease	1,096	1.4
Pulmonary	757	0.9
Skin disease	1,558	1.9
Defective spine	424	0.5
Defective chest	261	0.3
Defective extremities	550	0.7
Defective vision	17,928	22.8
Defective hearing	869	1.1
Defective nasal breath	11,314	14.0
Defective teeth	39,597	55.0
Defective palate	831	1.0
Hypertrophied tonsils	18,306	23.3
Postnasal catarrh	9,438	12.0
Defective metabolism	1,853	2.3

The **effects of school-life on growth in height and weight** are difficult to study, as there are very few children who are out of school in all countries where school attendance is compulsory, and there are therefore few with whom a comparison may be made. A study, however, has been made of the difference in the growths during the first school year, and also during the periods of the year free from school attendance.

According to Smith-Monard there was a difference in the rate of increase in weight and height of children during the seventh year of life according to whether they attended school or not, as follows:

	Inc. weight. kg.		Inc. height. c.m.	
	Boys.	Girls.	Boys.	Girls.
Not attending	2.2	1.9	7.4	5.6
Attending school	1.5	0.6	4.2	4.5
Increase of non-school over school	0.7	1.3	3 2	1.1

or an increase of 30 to 60 per cent. in weight and an increase of 30 to 40 per cent. in height of children not attending school over children attending school in their seventh year of life, showing plainly the effect of school life upon the growth of children.

There are also certain periods of school life when children not only stop gaining in height and weight, but actually lose weight; this is notably the case during examination periods. Thus, it was found by Ignatieff (Moscau) that 79 per cent. of pupils lost in weight during examinations, and in Stara Zagora (Bulgaria) it has been found that 68 per cent. of the children lost in weight during the same periods.

School Diseases.—There are no specific "school diseases," but a number of diseases are especially prevalent during school life; among these are especially noteworthy the eye, mouth, and throat diseases, cardiac diseases, defects in spinal column, infectious, general, and skin diseases.

Infectious catarrhal conjunctivitis is a disease very frequent among school children.

Trachoma, or granular conjunctivitis, is another of the eye diseases prevalent among school children of the poorer classes.

Myopia is one of the diseases directly due to school life, to study, defective light and illumination, improper position, faulty seats and desks, defective methods of writing, faulty print, and eye strain generally. Children who come to school with some degree of weak vision gradually develop increased myopia, reaching quite a high degree by the time of graduation. Thus, in New York schools the percentage of myopics in lower grade 8 was 8 per cent., while in the higher grade 2 it was 20.2 per cent.

The **mouth, nose, and throat diseases** prevalent among school children are coryza, adenoid growths, hypertrophied tonsils, recurrent tonsillitis, habitual nose bleeding, etc.

The **cardiac and circulatory diseases** are anemia, chlorosis, endocarditis, etc.

The **respiratory diseases** most frequent in school life are bronchitis, bronchopneumonia, and pleurisy.

The **digestive diseases** favored by school life are anorexia, constipation, and simple gastritis due to hurried meals, too short time for lunches, mental worry and strain, etc.

The **skin diseases** prevalent are scabies, ringworm, pediculosis, etc.

The **nervous diseases** especially resulting from school life are chorea, neurasthenia, etc.

Spinal diseases due directly to school conditions are scoliosis, kyphosis, and lordosis due to faulty seats, position, etc.

Among the **infectious diseases** raging in school are especially noted the exanthemata, the spread of which is favored by school segregation, also diphtheria, pertussis, parotitis, etc.

Causes of the Ill-effects of Schools on Health.—The etiological factors to which the pathological conditions referred to above are due are very numerous, but may be grouped into two broad influences: (1) The school buildings themselves, and (2) the influence of the studies.

The **influence of the school buildings** and **arrangement upon the health** of the school children may be summarized in the following conditions: Defective sites, soil, and foundation; dampness in cellar and walls; absence of fire protection; insufficient natural light, defective provisions for illumination, impure air, and defective provision for ventilation; inadequate floor and cubic space, overcrowding, congestion, defective methods of heating, plumbing, and cleaning; all the above factors of defective housing will influence the health of school children.

Other factors adversely influencing school children may be classified as follows:

Personal.	Physical, mental, and moral defects of children previous to entering school.
Economics.	Poverty of parents.
	Ignorance of parents.
	Undernourishment of children.
Studies.	Too early school age.
	Too long school day.
	Overfatigue and lack of recesses.

Curriculum.	Multiplicity of subjects.
	Difficult or unnecessary subjects of study.
	Improper methods of study.
	Competition, tests, examinations.
Teachers.	Personal factors.
	Brutality, ignorance, and carelessness.
	Discipline, punishments, etc.

Most if not all the harmful effects on health of school children may be traced to one or several of the causes enumerated above, causes which are important as bearing an intimate relation to child and public health.

Prophylaxis. School Hygiene. — Th preservation and promotion of the health of school children, and the prevention of the ill-effects of school life upon health may be accomplished (1) by the sanitation of school buildings, and (2) by rational methods of study and care of school children.

The **best sites for schools** should be selected; they should be dry, porous, well drained, free on all sides, distant from any buildings, far from factories, offensive trade establishments, markets, boiler-shops, saloons, elevated railroads, etc., far from any thing creating noise, smoke, smell, gases, or fumes.

It is desirable that a school site should occupy a separate whole block, near a public park, playground, etc.

The most modern **construction of sanitary school buildings** should be employed, and there should not be penuriousness or "economy" in this regard.

No existing structures built for other purposes should be reconstructed or made over for schools, but school buildings should be especially constructed for their purpose.

No school house, except in the poorest rural community, should be constructed of wood; brick and stone should be the materials of school buildings, and in large cities they should be constructed of fireproof reinforced concrete, or of steel frames with stone or concrete.

The number of stories in school houses should be limited, and no matter how fireproof a building may be, the school

children should be able to walk up to the upper stories, and not be compelled to use elevators. Four or five stories should be the limit in height.

The basement, or lower story, should run under the whole school building, should be high, dry, well lighted, and ventilated, and may be used for workshops, bathrooms, machinery, etc., but should not be used for playground or gymnasium; these latter should be either upon the school grounds or upon the roof.

Large entrance and exit doors should be provided in many places and on every floor: the stairways should be broad, light, and fireproof.

There should be in a school building not less than thirty square feet of space for each pupil, so that a school constructed for 1000 children should contain not less than 30,000 square feet of floor space.

There should be a limit to the size of school buildings, and three school houses for 10,000 children are better than two, or one, no matter how large and spacious this last one may be.

There is no need for too much ornamentation in school architecture; the interiors should be plain, smooth, junctions of ceiling and floors with walls be concave, and all projections, mouldings, etc., where dirt and dust may lodge, be eliminated.

The walls, floors, ceilings, and partitions should be soundproof, should also be damp-, fire-, vermin-, and dust-proof.

Solid floors of reinforced concrete are best for schools; the top of floors may be of hard wood laid in a narrow strip and well oiled or waxed.

The inner surfaces of walls and ceilings should be finished smooth and colored in bright tints.

The schoolroom is the unit of the school house; it should be oblong in shape, about 30 by 25 feet, and not less than 13 feet in height.

Ample provision should be made for dressing rooms, library, study rooms, auditorium, bathrooms, teachers' rooms, etc.

School House Lighting.—The window area of school houses should be not less than one fourth of the floor space; the top of windows should not be more than six inches from the ceilings; the windows should be square on top, and reach to about four feet from floor; the piers between windows should be as narrow as possible and bevel-edged, the panes made in large dimensions without intervening bars. The window glass should be ribbed, or prism glass.

Schoolrooms should be lighted from above, wherever possible, and from the left on all floors where light cannot be gotten from above.

Window roller shades, properly adjusted, may be necessary, but should be avoided, if possible, because of the dust they gather.

For artificial illumination, electric lights are the best, and there is no reason why in all larger schools this form of illumination should not be used exclusively, as it is the best.

School House Ventilation.—Theoretically no school house should rely upon natural ventilation, as such a ventilation, even with addition of artificial openings is not sufficient to provide the needed air and to make the exchange of air necessary in schools with large numbers of pupils in class rooms; while the opening of windows, etc., is objectionable on account of the cold, noise, and dust they let in. Therefore, all school buildings should be provided with mechanical ventilation, with a combined vacuum and plenum system of ventilation, with the supply of air carefully regulated as to temperature, quantity, humidity, and purity.

School House Heating.—Local heating is obsolete in all except small village schools. A central heating and ventilating plant should be provided for all large schools. Small schools may be provided with a central hot-water heating plant, but in all very large schools the indirect system of heating is the best, as it combines a rational system of heating with ventilation. This system consists in placing the heated steam radiators or coils in a separate air chamber, from where the warmed air is forced by proper motors and fans into the ducts leading into every room, where they end in inlets

in appropriate locations. The velocity and humidity of the incoming air may thus be regulated, and the air may also be filtered and partly purified.

School House Water Supply.—An ample supply of water is needed in schools. The supply fixtures should be conveniently situated so as not to necessitate too great distances to travel for obtaining a drink; some sanitary individual drinking cups should be provided, and the water supplied for drinking purposes should invariably be filtered through a properly adjusted and frequently cleaned filter.

School House Plumbing.—There should be an ample provision for wash rooms, basins, shower baths, urinals, water closets, all situated conveniently, in well-lighted, heated, and ventilated apartments; the fixtures made of porcelain or enamelled iron, the floors, walls, and ceilings of such apartments constructed of stone, tile, or pressed glass. Water closets should be provided with automatic flush apparatus.

School House Cleaning.—Daily, weekly, and periodical cleaning of schoolrooms should be the rule; wet methods of cleaning should invariably be used, and, whenever possible, a complete system of vacuum cleaning installed.

Indeed, there should be applied to all parts of school construction the latest, the most advanced, and modern methods of construction and equipment, because the preservation and promotion of the health of the next generation is the corner-stone of public health.

School Furniture.—The school furniture bears an important relation to the health of the pupils.

School furniture consists of desks, seats, platforms, blackboards. Of importance also are the books, slates, writing-paper, and pens and pencils.

The construction and arrangements of the desks and seats are of great importance in the matter of position and attitude of the pupil. Owing to the variations in the height of each pupil the desks must be individual and adjustable, so as not to compel him to assume unnatural attitudes in sitting and writing, to prevent formation of spinal curvature; the distances of the desks from the blackboard should be adjusted according

to the strength of vision of each pupil. The seats and desks should therefore be adjustable and periodically adjusted after physical examination of each pupil.

Desks and seats as well as teachers' platforms should not be permanently attached to the floor, but should be made removable.

The blackboards should be so placed as to be visible to all pupils, and the writing upon them should be so large and distinct as to be visible without strain by the pupils in the rear seats.

Slate blackboards are preferable to wood, but the writing upon same with chalk producing large quantities of dust is not sanitary, and should be replaced by some improved method. In some schools manila paper of proper shades with writing painted with brush has been substituted for slate and chalk.

The books used in schools should be printed in large types, and should be disinfected at stated intervals.

Pictures, charts, globes, models, instruments, etc., should be coated with varnish, be smooth and easily cleaned.

The **correction of the other etiological factors of school dangers to health** may be summed up in the following measures: (1) Counteraction of injurious home influences; (2) care for the proper feeding of school children; (3) regulation of school hours, pauses, rest, etc.; (4) a rational method and system of study; (5) education of a proper teaching staff; (6) prevention of overcrowding, congestion, etc.; (7) promotion of health and vital resistance; (8) isolation of the physical, mental, and moral defectives; (9) prevention of the spread of infectious diseases; (10) proper medical school supervision.

If the school is to have a lasting and thorough influence upon the physical, mental, and moral well-being of the next generation, the school child should be the ward of the State, at least in so much as the **supervision of the home influences** are concerned. Whether due to alcoholism, brutality, ignorance, or poverty, subversive home influences should be counteracted by the school, so that the child does not lose at home what it gains in health and mental and moral develop-

ment in school. Whether the school authorities, or a separate branch of the education department, whether through lectures and popular education of parents, or through the aid of visiting nurses to the homes, or by some other means as yet not devised, the harmful home influences upon children should be controlled and counteracted.

A most important prophylactic measure, and a step of paramount value in the preservation and promotion of the health of school children is their **proper feeding.**

It is a universal dictum that no healthy mind can exist in an unhealthy body, and that a body cannot be healthy if it is not properly or sufficiently fed.

Whether it is due to ignorance of the parents, or, what is more true, to poverty, as has been lately proved in the case of the school children of many large cities, a great many school children come to school hungry and stay hungry during the day. That neither physical nor mental development is possible under such conditions is self-evident, and no rational system of education can afford to neglect this important factor.

Whether *all* school children, or those only who apply, should be fed; whether such feeding should be absolutely *free*, or paid for by a nominal sum; whether it should be done by private, public, or school authorities; whether breakfasts and lunches, or but one meal, should be furnished, are all questions for the social economists to decide. On the part of hygiene the demand is only made that the school child should be properly fed and nourished. Nor does it deter the sanitarian from such demand, that the argument is advanced that feeding of children by the State may lead to the demand to have them clothed, shoed, furnished with eyeglasses, etc.

School Age and Hours.—The regulation of the age of entrance to schools, the regulation of the length of school day, the recesses, prevention of overfatigue, etc., are matters of importance.

The points upon which educators and sanitarians seem to have agreed are as follows:

That no child should be made to attend school before the age of six, or, better, seven, and, if in delicate health, later.

That younger children from five to seven years of age may attend kindergartens, provided their stay indoors is limited, and the close needlework, etc., requiring eye strain are eliminated.

That the length of the school day be graded to the age, sex, grade of study, physical condition, and mental state of each pupil; that recesses should be had after every forty-five minutes of study in the higher grades and thirty minutes in the lower grades, with pauses of ten minutes in the lower and fifteen minutes in the higher grades.

That mid-day recesses, wherever there is an afternoon session, should be longer than commonly allowed, and that serious studies, or those requiring mental strain, be not pursued afternoons.

That the **current multiplicity of studies** be substituted by the most important and useful subjects, and that education should fit the child for the struggle of existence in the world, instead of filling his head with useless knowledge to be soon forgotten.

That dead languages and abstruse subjects should be made electives to older children with special abilities or desires for scientific vocations.

That **methods of study** be made more inductive, experimental, and objective; that less attention be pain to definitions, dates, and figures; and that the efficiency of the pupil be gauged not upon lucky answers in periodical tests and examination, but on progress during the entire year.

That **home work, examinations,** and **competitive trials,** so injurious to health, be abolished, or, at least, eliminated as much as possible.

That **defectives physically, mentally,** or **morally** should not be left with the other pupils, but should be segregated and taken care of by special instructors.

For the introduction of an ideal hygienic system of teaching it is no less necessary that there be trained a **specially fitted corps of tutors,** sympathetic, earnest, devoted to their duty, permanent, well paid, and secured against changes in complexion of educational boards, and that a teaching staff who look upon their work as a transitory occupation, or stepping-stone to marriage, be eliminated.

The **overcrowding of pupils in classes,** the placing of fifty or sixty pupils in one schoolroom, is a disgrace to the municipality tolerating it, a torture to the teaching staff, and a menace to the health of the children.

Classes of over twenty-five are difficult to handle, and over forty impossible to control; the teacher's time should not be occupied in matters of discipline, but in the mental development of the pupils, and this is impossible if the teacher cannot have a personal acquaintance with, and control of, each pupil.

The **promotion of the health of the school children** may be furthered by a rational system of playgrounds, gymnastics, physical exercise, bathing, swimming, etc.

All physical exercises and sports should be under the supervision and control of a medical instructor, and all pupils suffering from congenital or acquired cardiac trouble should be excluded from the general classes in such subjects.

As an aid for the promotion of health the educational system should provide in every class and grade of school study and teaching in personal hygiene, and of public hygiene in the higher classes.

The **control of the sanitation of schools,** of the health of school children, of the preservation of their physical bodies, and the prevention of constitutional and infectious diseases should be made the duty of a rational system of medical school supervision.

A **medical supervision of schools** that should be efficient can only be accomplished by the appointment of reliable, permanent, competent, well-paid physicians, who should be permanently and completely attached to the school and be a part of the educational staff, who should be debarred from outside practice, and there should not be more than 500 pupils under the supervision of each.

A **rational system of medical school supervision** would also embrace the appointment of oculists, dentists, nose and throat specialists, teachers of hygiene, and visiting nurses

Some of the duties of medical inspectors of schools would be: (1) Physical examination of pupils entering school; (2) annual thorough physical examination. (3) daily physical

inspection; (4) isolation of suspected cases; (5) removal and quarantine of contagious cases; (6) supervision of physical exercises of pupils; (7) treatment of physical and mental defectives; (8) prevention of correctible defects; (9) teaching of hygiene to pupils and teachers; (10) sanitary supervision and inspection of school house, rooms, desks, seats, etc.; (11) adjusting of desks and seats according to growth, height, and eyesight of each pupil; (12) the systematic supervision, study, care, and control of the health of the school children.

While such an outline scheme of medical school supervision is as yet not introduced in its entirety in modern schools, there are clear indications that it is bound to come in time, and, when it does come, will certainly be a great sanitary advance and a powerful means for the promotion of public health.

QUESTIONS.

What are the effects of schools upon the health of pupils?
What special diseases are favored by school life?
What are the so-called "school diseases?"
What are the effects of schools upon the eyes of children?
What are the effects of schools upon the nervous system?
What role do schools play in the dissemination of infectious diseases?
What are the principal conditions of school life adversely affecting school children?
Describe the proper construction, lighting, warming, ventilation, and plumbing of school houses.
What are the sanitary requirements of school furniture and utensils?
What are the hygienic requirements of the school curriculum?
What are the aims and purposes of medical school inspection?
What are the essential features of a modern school inspection system?

CHAPTER IV.

INDUSTRIAL HYGIENE.

OCCUPATION AND HEALTH.

Industrial hygiene is the branch of public hygiene which deals with the relation of occupations to health, with the effect of industries upon the workers; with the preservation and promotion of the public health by eliminating the adverse causes incident to industries, and with the prolongation of the life of workers by improving the conditions under which they work and live.

The **relation of occupation to health** is a very intimate one, and occupation is one of the most important factors of environmental life influencing public health, mortality and morbidity.

This claim is substantiated by the fact that the whole population, with the exception of the too old or too young, is engaged in some gainful occupation, in which from one- to two-thirds of life are spent; that certain dangers to life, limb, and health are known to be due directly to certain occupations, and that certain industries are known to cause directly, or indirectly, certain pathological conditions, which are fatal to life.

Facts from ample statistical data show that:

1. The mortality of workers in certain industries is greater than that of workers in other industries.

2. That certain industries show a persistently larger mortality from certain diseases than others.

3. That certain occupations show a persistently greater number of fatal and non-fatal accidents than others.

4. That these figures are true in various countries and periods.

5. That the mortality and morbidity of workers is greater whenever there are in the industries certain elements known to be dangerous to health and life.

The **effects of industries on health** may be summed up in the following:

1. Sudden death due to accidents, falls, burns, explosions, etc.
2. Total or partial disability from the same causes.
3. Sudden deaths from acute intoxications by poisons, fumes, and gases.
4. Deaths from chronic intoxications by the same elements.
5. Deaths due to infectious material in industries.
6. Diseases due to direct action of dangerous elements in trades.
7. Diseases due indirectly to industries and occupations.

The **causes of the ill-effects of industries on life and health** are due to a large number of factors, which must be considered separately and individually.

The **etiological factors** playing an important role in the causation of industrial diseases and occupation mortality may be stated as follows:

Group I.—Adverse conditions due to personal factors:

Personal health of worker.
Susceptibility, vitality, and resistance.
Nutrition and personal hygiene.
Ignorance, carelessness, etc.
Choice of trade.
Sex.
Age.

Group II.—Adverse conditions due to place of work:

Outdoor and indoor work.
Surface and subsurface work.
Factory, workshop, and homework.
Factory sanitation.

Group III.—Adverse conditions in the industries themselves:

Active and sedentary work.
Extremes of climate.
Light, temperature, and humidity.

Air pressure.
Attitude and position.
Duration and pauses.
Fatigue.
Tension, worry, and responsibility.
Insecure tenure, etc.
Wages and compensation.

Group IV.—**Adverse conditions due to materials and processes.**

Dust.
Poisons.
Gases and fumes.
Infectious material.
Hazards and accidents.

A brief review of the above various adverse factors is necessary in order to understand the principles of prevention of industrial diseases.

PERSONAL FACTORS.

The *individual health* and the **normal physical development** of the individual worker are of prime importance in the influence of industry upon health. The greater the sum of health the worker starts out with at the beginning of his career the more efficient will be his work, and the less he will be liable to suffer from the adverse conditions incident to his work.

The *susceptibility* and *vital resistance* partly depend on the physical health of the worker, and partly on individual idiosyncrasies. Thus there are certain persons who seem to be less susceptible to certain poisons than others; and there are many who evidently enjoy a certain immunity against the effects of poisons and infections to which others very quickly succumb.

Personal Hygiene.—The nutrition, housing, clothing, and habits play an important role in the ability of workers to

resist the adverse influences of certain industries. A faulty or inadequate nutrition, indulgence in alcohol or drugs, improper or insufficient clothing, defective insanitary housing, and other unhygienic personal factors reduce the health of the individual, lessen his vital resistance and make him a fitter subject to be influenced by any and all adverse conditions incident to industrial life.

Ignorance, bravado, and carelessness have an important share in the etiology of accidents to which so many deaths are due.

The **choice of trade,** while in a large number of cases determined by natural selection, is due in the majority of cases to chance and personal whim, although it is of the utmost importance to the health of the worker, for upon the right choice of occupation depend not only his efficiency but also his health and length of life.

A feeble individual selecting a strenuous trade because of its larger emoluments; a congenital cardiac defective selecting caisson work, etc., will soon succumb to the effects of trade, whereas he might have lived much longer had he selected an occupation equal to his physical power. The same applies to phthisically inclined individuals selecting a dusty occupation, etc.

Sex.—The injurious effects of industry upon women are due to the following factors:

1. The comparative greater physical weakness of women.
2. The greater disposition to toxic influences.
3. The effects of labor upon the reproductive organs.
4. The periodical semipathological state of women.
5. The effects upon offspring.
6. The effect upon children and home.

Physical Strength of Women.—While women, as a rule, choose trades requiring little physical effort, the length of work and the conditions under which it is carried on are too strenuous for them.

It is well known that women's **susceptibility to industrial poisons** is greater than men's. Especially is this the case with lead, mercury, and phosphorus. There are ample statistical data showing the immensely greater proportion of deaths

from industrial poisons among women as compared with men. workers.

Certain **conditions of work in women:** sitting, prolonged standing, work on sewing machines, etc., are known to be the cause of congestion of uterus and appendages, malpositions, and chronic inflammations.

The **semipathological state** in which women find themselves during several days in each month are prolific causes of the harmful influences of industries upon the women compelled to work during these periods. The natural congestion of the reproductive organs during these periods is increased by certain work, and is bound to become injurious to health.

The **effects of industrial life on the offspring** are seen in the appalling infant mortality and large abortion and miscarriage rates prevalent in all industrial towns. Abortions and miscarriages are due to the hard work during the later periods of pregnancy, and especially to the effects of certain poisons. Thus, according to Tardieu, out of one thousand pregnancies among female lead workers there were not less than 609 abortions. Miscarriages and abortions among female workers are also caused by the continuous labor and too heavy tasks performed by them.

Effects on the Home of Working Women.—The large rate of infant mortality among the working classes is also due to the lack of care, the artificial feeding, and neglect of the children by their working mothers. To the same causes are also due the neglect of the health, proper preparation of food, and care of the male workers of the family, the neglect of home, etc.

Age.—According to the United States Census of 1900 there were not less than 1,752,187 children under the age of sixteen employed in various occupations, as follows:

Textile industries	80,000
Mines and quarries	25,000
Tobacco and cigars	12,000
Glass industry	7,116
Wood industries	10,000
Laundries	7,000
Bakeries	2,000
Stores	20,000
As servants, waiters, etc.	138,000
As messengers	42,000

Baneful as are the effects of industrial life upon women, they are still more so upon children.

The **injurious effects of labor on children** may be summed up as follows:

Injury to the weaker organism.

Interference with growth and physical development.

Production of spinal and bone deformities.

Production of pathological conditions predisposing to certain diseases of early and late life.

The stunting of mental and moral development.

Physical, mental, and moral degeneration.

Shortening of life.

The effects of industrial dust, poison, etc., is comparatively greater on children than on adults, and the relative number of all industrial accidents is greater among children workers than adults.

Undoubtedly child labor, if very extensive and if persistent and prevalent, is bound to produce a debilitated generation, and be of the greatest influence in the physical deterioration of the race.

THE PLACE AND CONDITIONS OF WORK AND HEALTH.

The place where the work is carried on influences the workers' health.

The morbidity and mortality of workers differ according as the labor is **indoor work** or **outdoor work.**

This is undoubtedly due to the difference in the purity of air, to the lesser fatigue felt by outdoor workers, and in the decrease in the liability to respiratory diseases and mortality from tuberculous diseases which outdoor workers enjoy.

The following figures from Ogle are often quoted in proof of the advantages of outdoor work:

MORTALITY RATE OF ADULT MALES BETWEEN THE AGES OF FORTY-FIVE AND SIXTY-FIVE FROM TUBERCULOSIS AND RESPIRATORY DISEASES, TAKING THE DEATH RATE OF FISHERS AS A STANDARD, 100.

		Tuberculosis.	Other respiratory diseases.	Total.
Outdoor workers	Fishers	55	45	100
	Gardeners	61	56	117
	Agricultural laborers	62	79	141
Indoor workers	Storekeepers	84	59	143
	Drapers	152	65	217
	Printers	233	84	317

Subsurface location of work is more unhealthy than work carried on upon the surface, other things being equal.

Thus, tunnel workers, miners, and all workers underground not only are liable to greater dangers from accidents, explosions, etc., but also suffer from absence of light, fresh air, great heat, accumulation of gases, constrained attitudes, etc.

The greatest danger of subsurface workers is from the effect of increased air pressure, as will be alluded to later.

The adverse effects of **home work**, or **"sweat-shop" work**, are partly due to the insanitary conditions under which home workers are compelled to work, and partly to other causes, such as the tendency in home work of participation by the women and children of the family; the longer periods of work, the dangers of infecting the children by the dust or infective materials carried upon work (as in hides, fur, tobacco); and by the added danger of spreading infection from the house (scarlet fever, diphtheria, tuberculosis, etc.) by the infected garments or work materials. Sweat-shop workers are also the worst paid, and their health is below the average factory workers.

Factories and Workshops.—The effects of workshops and factories upon the health of the workers depend on the proper construction, the soil and site, the dampness of foundation and walls, insufficienct light and illumination, inadequate ventilation, improper heating, faulty drainage and plumbing, and the general insanitary conditions of the premises.

The above factors are not peculiar to industrial establishments alone, but they have greater influence on the health of the workers, because of the abnormal conditions in which the latter are placed during their work.

ADVERSE INDUSTRIAL CONDITIONS.

Besides the personal factors and the influence of the place of work, there are in many if not most industrial occupations certain abnormal conditions which cannot fail of having a deleterious influence upon the health of the workers. These are chiefly those described in the following paragraphs:

Active and Sedentary Occupations.—As a rule, those occupations which require sedentary postures show greater liability of their workers to respiratory and tuberculous diseases, and the morbidity and mortality of such workers is greater than that of workers engaged in active occupations.

Statistical data clearly show the greater mortality of clerks, bookkeepers, copyists, typewriters, stenographers, engravers, tailors, shoemakers, seamstresses, etc.

A constant sitting posture at work presupposes, as a rule, lack of muscular action, bent body, compressed chest, deficient metabolism, and lack of proper oxygenation of the blood. It is, as a rule, followed by anemia, anorexia, constipation, gastric catarrh, torpid liver, hemorrhoids, venous stasis, low vitality, tendency to respiratory diseases, especially pulmonary tuberculosis.

These effects are more pronounced on women, children, and adults between the ages of fifteen and forty-five. After the latter age sedentary occupations are not so harmful.

Extremes in Climate and Temperatures.—Exposure to extremely cold or extremely hot climates are not followed by bad effects if the health of the workers is good, if they are clothed and fed properly, and if the change from one climate to another is not too sudden. Thus, arctic explorers seem not to suffer much from the cold, apart from occasional frostbites, etc. Hot climates seem to be more dangerous than very cold; thus, soldiers, sailors, and workers in tropical countries seem to suffer from debility, anemia, are subject to special tropical diseases, and the rate of mortality among them is higher.

Artificial high temperatures are prevalent in many industries.

Bakers, cooks, blacksmiths, firemen, stokers, furnacemen, blast-furnace workers, glass, sugar refinery workers, glass blowers, electric welders, Turkish-bath attendants, miners, and many others are subject to and are affected by high temperatures.

The general effects of too high temperatures on workers are excessive perspiration, chills, thickening of blood plasma, tendency to respiratory and circulatory diseases, to affections of the eyes and skin, to rheumatism, tuberculosis, etc.

Light.—Insufficient, improper, and inadequate light and illumination of workshops cause eye strain, headaches, and eye defects. A too glaring light is injurious to the eyes, causes inflammations, predisposes to cataract formation, and other eye diseases. Workers who are exposed to such conditions are blast-furnace and glass workers, engineers, electric workers, stokers, and others.

Humidity.—A too moist air is injurious to health by interference with perspiration, by overheating and difficulty in respiration. Constant work in an air which has a high relative humidity predisposes to rheumatic and respiratory affections, and is dangerous to those phthisically inclined.

Workers in textile factories are especially subjected to very moist air, it being the practice to keep the relative humidity of the air in such factories very high for the better spinning of the thread.

Position and Attitude.—The position maintained during work is not without its influence on health.

Salesmen and all who constantly stand on their feet at work often suffer from varicose veins, hemorrhoids; the women from congestions of the pelvic organs.

The constrained attitudes which engravers, draughtsmen, copyists, shoemakers, tailors, etc., are compelled to assume may cause defective development of the chest in younger workers, a stooping habit, narrow chest, defective oxygenation, and tendency to respiratory diseases. The constrained attitude which some coal miners are compelled to assume while "kirking," or undercutting seams, have been referred to as causing nystagmus.

Air Pressure.—There are a number of industries which have to be carried on under lesser or greater air pressure than the ordinary air pressure of fifteen pounds to the square inch to which we are subjected on the earth's surface.

Industries with decreased air pressure are exemplified by mountain climbers, aëronauts, bridge workers.

Industries with increased air pressure comprise, for example, caisson workers, tunnel workers, divers, pearl seekers, etc.

The **effects of diminished air pressure** are those of the lack of oxygen. Rarefied air seems to be especially dangerous to those suffering from cardiac disease.

Results of Increased Air Pressure.—Caisson Disease.—This term is applied to a group of symptoms the pathology of which has not as yet been fully determined and agreed upon, but which are distinct and characteristic of workers in compressed-air chambers with air pressures two or three times greater than the ordinary.

The symptoms appear not on compression, but on decompression; that is, on the removal of the workers from the compressed-air chambers. The symptoms are pain in the ears, severe cramps—"bends"—in the joints and muscles, nose bleeding, vertigo, vomiting, temporary or permanent paralysis of the lower extremities, unconsciousness, and, not infrequently, sudden death.

Not all workers seem to suffer equally; the less normal in health a worker is the more quickly he succumbs to "bends;" in most cases the effects are noted only when the pressure is at least forty-five pounds.

According to Oliver, "caisson disease" is not so much the result of a toxemia as of a "sudden liberation of gas and the presence of air emboli in the blood, rupture of capillary vessels, and the presence of free air and blood in the tissues."

Fatigue.—Fatigue is a condition of lowered vitality with an accumulation of waste products in the body and formation of special toxins, due to faulty metabolism, lack of vital resistance, overwork, violent exercise, tension, strain, etc., and frequently found in all workers who have to undergo arduous labor, physical or mental strain.

Fatigue is a purely personal factor, and depends on the individual idiosyncrasy and susceptibility. A work that may cause fatigue symptoms in one worker may not produce it in another, and the same individual is more subject to it at one time that at another.

Fatigue is also influenced by environmental factors, or the various conditions by which the work is attended; but, as a rule, other things being equal, the harder the work the more prolonged, the greater the strain, the velocity of the work, etc., the sooner and greater the fatigue.

General **fatigue manifests itself** in a diminished vitality, in a lessened resistance, in a disability to perform the same amount and character of work, and a predisposition to succumb to any detrimental influences and diseases.

The overworking, or too prolonged use of one part of the body, or one set of muscles, or one organ, is often followed by "fatigue neuroses," which manifest themselves in loss of motor, sometimes of sensory, functions of the particular organ or set of muscles. General fatigue, alcoholism, general weakness of the organism predispose to "fatigue neuroses."

The most common example of such neuroses is seen in the so-called "writer's cramp," a convulsive affection of the fingers, loss of power of coördination noted in some writers, copyists, and others. A similar affection is met among milkmen, typesetters, telegraphers, cigar makers, violinists, etc.

The **duration of work** is a potent factor in the effects of work on health. The standard of normal activity differs with the individual worker, the place and conditions of the work. But a too prolonged daywork, or work too prolonged, is bound to cause fatigue and cause the body to be in a state extremely liable to be influenced by any untoward causes and become a prey to disease and infections.

The **pauses in work** are also not without influence, because of the necessity for the recuperation of the body forces after continuous work. As much, if not more, work may be accomplished during ten hours with several pauses than with no pause at all. Longer pauses than those commonly allowed would be very beneficial to health; the same applies to the

necessity of daily, weekly, and seasonal pauses, in form of Sundays, holidays, and vacations.

Tension of Work.—The effect of duration of work will partly depend upon the tension with which it is carried on. When work is performed under great stress, tension, artificial stimulus, etc., the point of fatigue arrives sooner, and its ill-effects are more marked.

Physical Strain of Work.—The carrying of too heavy loads, lifting weights, and performing too great physical tasks above the strength of the individual are bound to react harmfully and cause cardiac dilatation, hernias, dislocations, aneurysms, etc.

Mental Strain of Work.—Worry and responsibility which are such regular features of industry, especially among the owners, managers, etc., are followed by injuries well known to practitioners on insanity and diseases of the nervous system.

Compensation and wages paid to workers determine their mode and standard of living, their hygienic surroundings, and their social and economical welfare, and are important factors of health.

INDUSTRIAL DUSTS AND HEALTH.

There are a large number of industries accompanied by the production of a considerable amount of dust.

The **effects of exposure to dust upon health** vary according to amount of dust inhaled, kind and character of dust, the period of exposure, the individual health of the workers, the condition of the work, and many other factors.

Certain dust, metal or mineral, being sharp-edged, may cause mechanical injury in the delicate mucous membranes of the respiratory passages, injuries which may then become foci of infection in the presence of infective germs.

All dusts cause an irritation of the mucous membranes of the eyes, nose, mouth, and throat, producing catarrhal conditions, and causing cough, discharge, and expectoration.

A prolonged inhalation of dust produces deposits in the bronchi and bronchioles and sometimes in the parenchyma of the lung, and the constant irritation produced by such

deposits may cause the production of an active connective-tissue inflammation and consolidation of lung tissue in nodules and distinct areas.

Various kinds of dust conditions of the lungs of workers in dusty trades are recognized according to the kind of dust inhaled. Although they all bear the name of "**pneumonokoniosis,**" they are subdivided into **anthracosis** (coal miner's phthisis), **siderosis, chalicosis, tabacosis,** etc.

The **pathological process in the lung** may be purely fibrinous, or the infection may become, in the later stages, mixed with tubercle bacilli; the prevalence of mixed infections is marked.

The constant inhalation by workers of large quantities of dust is very harmful to health, and is the cause of the increased morbidity from respiratory and tuberculous diseases and of increase in the general mortality of workers in dusty trades.

According to Tatham, the mortality from tuberculosis and respiratory diseases among the workers of twenty-two dusty trades was twice as great as that of agricultural workers, and in eight industries three and four and a half times greater.

According to Sommerfeld, the mortality of Berlin workers in dusty occupations was 5.42 per 1000, while at the same time the mortality of workers in non-dusty trades was but 2.39.

According to Frederick Hoffman, the proportion of mortality from consumption in 22,987 deaths from all causes was 28 per cent. of the mortality from all causes in persons over fifteen years of age. Contrasting this death rate among dusty industry workers and the death rate from consumption of 9.5 among agricultural and other outdoor workers, the large increase of death from consumption among dusty workers is clearly demonstrated.

Dust affects the worker not only through the respiratory system, but also through the digestive tract; it also causes injuries to the eyes, and is followed by certain skin affections.

Hoffman's[1] **classification of dusty trades according to dust produced** is as follows:

[1] Mortality from Consumption in Dusty Trades. F. Hoffman, Bulletin of the Bureau of Labor, vol. lxxix,

Group I.—Exposure to Metallic Dust: Grinders, polishers, tool and instrument makers, jewellers, gold leaf, brass workers, printers, compositors, engravers, pressmen.

Group II.—Exposure to Mineral Dust: Stone, marble, cement workers, glass blowers, glass cutters, diamond cutters, potters, plasterers, paperhangers, moulders, core makers, lithographers.

Group III.—Exposure to Vegetable-fibre Dust: Cotton ginning, textile, flax, linen, hemp, cordage, paper manufacturers, weavers, spinners, hosiery knitting, lace making, jute, and woodwork.

Group IV.—Exposure to Animal and Mixed Dust: Furriers, taxidermists, hatters, silk, wool, and worsted workers, carpet, rug, rag, and shoddy workers, hair matresses, upholsterers, etc.

According to Hoffman, the mortality rate from consumption varies according to each group.

Thus the mortality rate of metallic trades is 37.4 per cent.; organic dust is 23.7 per cent.; mineral dust is 28.6 per cent.; vegetable dust is 27.4 per cent.; animal and mixed is 32.2 per cent.; all dusty trades is 28 per cent.

INDUSTRIAL POISONS AND HEALTH.

The **chief industrial poisons** are lead, arsenic, and mercury, although phosphorus, copper, zinc, brass, and chromium poisoning are frequently met with in various industries.

Lead.—The number of trades in which lead is used is too large to be all named. A few of the most common industries in which lead is largely employed are the following: Lead workers and smelters, lead miners, printers, filers, grinders, compositors, typefounders, typesetters, lithographers, stereotypers, potters, enamel makers, glass, gold, silver, and patent-leather workers, painters, manufacturers of lead shot, amber workers, plumbers, etc.

Lead **enters the system** by the lungs, digestive tract, and through the skin.

Lead **causes** acute or chronic intoxication.

The **effects of chronic lead poisoning** are first noticed by the following symptoms: constipation, cramps and "lead colic," anemia, bluish line on edge of gums, anorexia, pain in joints. A further persistent exposure to lead poison is followed by lead palsy, arthralgia saturnina, loss of motor power in hands and feet, wrist-drop, progressive muscular paralysis, multiple neuritis, temporary or permanent blindness, convulsions, insanity, and death.

The **mortality of lead workers** is very great in proportion to other workers.

Women and children suffer more greatly than men. In some lead-smelting mines in Prussia there were, in 1905, 145 cases of lead poisoning with 3726 days lost among 766 workers.

Among those working in the lead trades, printers are well known by their high mortality from tuberculosis.

Arsenic.—Arsenic is very extensively **used in** the arts and trades. Among others, it is used by taxidermists, by felt finishers, manufacturers of fuchsine, by glass workers, wall-paper makers, manufacturers of artificial flowers, textile fabrics, bronze colors, by painters, paris green manufacturers and packers, etc.

Arsenic **affects** the skin, gastro-intestinal tract, respiratory and nervous systems. Upon the skin arsenic causes eczematous eruptions, vesicles or pustules. In the respiratory passages arsenic causes catarrhal inflammations. Colic, gastritis, diarrhea and gastro-intestinal disturbances are the result of its action upon the gastric tract. Of the nervous disorders due to arsenical poison, the following are specially marked: loss of tendon reflexes, progressive muscular atrophy, local anesthesia, multiple neuritis, trophic sores, ataxia, etc.

The poison **enters the body by** the mouth, lungs, and skin.

Mercury.—The industries in which mercury is largely used are, among others, the following: quicksilver mines, also in gold and silver mines; manufacture of barometers, thermometers, electric meters, silvering mirrors, manufacture of pharamaceutical preparations, the felt and fur industries,

chemical works, powder works, artificial flowers, photography, lithography, etc.

The mode of **introduction into the system** is by inhalation of the fumes, by ingestion of the salts, and by absorption through the skin.

The **effects of chronic mercurial poisoning** manifest themselves by stomatitis, gastric disturbances, metallic taste in the mouth, inflammation and ulceration of the gums, cachexia, tremors, paralysis, melancholy, loss of memory, etc.

The **percentage of mercurial poisoning** among mercurial workers, ranges according to some authorities from 25 to 85 per cent.

Phosphorus.—The danger of phosphorus poisoning is limited almost entirely to workers in match factories, where such matches are made from the yellow phosphorus. Red phosphorus is not dangerous.

Among the milder **symptoms of phosphorus poisoning** are gastric and bronchial catarrh, anorexia, caries of the teeth. Necrosis of the bones, especially of the lower maxillary, is a frequent sequel of phosphorus poisoning in operatives with caries of teeth.

Brass.—Brass is an alloy of zinc and copper, and brass founders, cutters, filers, and polishers are subject to effects of the brass dust.

Brass workers suffer frequently from what is called "brass founder's ague," a feverish condition accompanied by chills, shivering, vomiting, sweating, headache, and depression.

Copper and zinc workers are sometimes subject to the effects of inhalation of the dusts of these metals, the nature of which is not specially characteristic.

Bronze workers suffer from a combination of poisons, as the bronze powders are mixed with different metallic ingredients each having its specific action.

Chromium is used in the manufacture of dyes, coloring of paper, fabrics, etc.

The **effects of chromium** are marked on the skin, nasal mucous membrane, in which they cause ulceration and perforation, also upon the eyes.

INDUSTRIAL GASES, FUMES, AND VAPORS AND HEALTH.

Occurrence and Frequency.—The occupations in which perceptible quantities of dust or definite poisons are produced are few in comparison with the vast number of industries in the processes of which some noxious gases, fumes, or vapors are evolved.

The industrial processes in which chemical agents and gases are produced, which, when absorbed or inhaled, may become dangerous to life and health, are so manifold and diverse that but a mere enumeration would take several pages. Nor is it always possible to trace the harm done to workers in some of the chemical trades to one or the other poison, or gas, or fumes, for in most of those industries complicated processes are carried on simultaneously, evolving a number of noxious and toxic elements, exposing the workers to a number of various influences.

Examples of Gas-producing Industries.—The coal-tar industry, may serve as an illustration. In this trade there are several dozens of products and by-products produced, each of which may be injurious to health; and it would be difficult to determine which of the deleterious influences are the ones producing the most injury. In the india-rubber trade, as another example, the workers are exposed to the vapors of naphtha, to the fumes of carbon disulphide, to excessive heat, and to a number of other injurious influences.

Some of the **principal gases** and **fumes** which are injurious to health are the following: sulphur dioxide, sulphur, hydrogen, and other sulphur compounds; carbon monoxide, dioxide, bisulphide, and other carbon compounds; nitric acid, hydrochloric acid, ammonia, chlorine gas, iodine, bromine, petroleum, benzin, nitrobenzol, aniline dyes, and all coal-tar products, chromium, potassium, alum, iron, lead, turpentine, cyanogen compounds, dynamite, etc.

The **dangers from gases and fumes depend on** the toxicity of the substances, the irritating nature of the fumes, the corrosive action upon skin and mucous membranes, the danger

from burns, scalds, and explosions, and, lastly, from the excessive temperatures which are the rule in such establishments.

The **mode of introduction into the system** is different from that of dusts, or of poisons. While dust acts mostly upon the respiratory system, gases and fumes have specific actions upon the eyes, mucous membranes, and the blood. Some of the fumes which are products of various industries act as virulent poisons, and their action may prove fatal within a short time after exposure, as, for instance, after inhaling gases like carbon monoxide, sulphuretted hydrogen, bromine, chlorine, cyanogen, etc. The **effects of irritating gases and fumes** upon the eyes, the skin, and mucous membranes has already been alluded to, and are very marked in the numerous skin affections, erosion of the mucous membranes of the nose and mouth, and the various ulcerative and inflammatory changes in the skin of hands, fingers, face, and arms.

The **mortality and diseases of the chemical trades** is very large. According to Roth, the mortality is 7 per 1000 among Austrian workers. The diseases by which they are affected were distributed as follows: 25.7 per cent. were burns, contusions, and scalds; 19.9 per cent., affections of the respiratory tract; 14.7, digestive tract; 10.8 per cent., skin diseases; and 10.5 per cent., general diseases. The percentage of mortality from respiratory diseases is also very high.

Among the chemical trades which are extremely dangerous to health we may include the manufacture of bleaching powders.

Chemical trade accidents are very frequent; indeed, the number of industrial accidents is greater in chemical trades than in any other industry except the extrahazardous.

INDUSTRIAL INFECTIONS AND HEALTH.

Dangers from Infection.—There are a number of trades in which the workers are exposed to infection by pathogenic germs which may adhere to the material of the work.

Trade Infections.—Tailors, rag pickers, rag sorters, laundry workers, etc., may be infected by germs of **scarlet fever, typhoid, diphtheria**, etc., which may adhere to the stuffs upon which they work; gardeners may be infected with **tetanus**; horsemen, coachmen, etc., with **glanders**; wool-sorters, tanners, skinners, with **anthrax**; nurses with **various communicable diseases** of the persons of whom they take care; tunnel workers with **anchylostomiasis.**

"**Rag sorter's disease**" is a name given to infection with anthrax from which handlers of wool, hides, and hairs of animals dying of anthrax may suffer at times. According to Neisser, there were 269 cases of anthrax, with 67 deaths, in England between the years 1899 and 1904. Kober quotes Ravenal as reporting twelve cases of anthrax in three localities in Pennsylvania during 1897.

"**Anchylostomiasis**" is an infective disease from which many tunnel workers suffer. In one pit in Hungary 80 per cent. of all the workers suffered, in another in the province of Liege, 50 to 60 per cent. had the disease. The malady which presents an aggravated form of pernicious anemia is due to a minute parasite, or hookworm, which fixes itself by its hooklets in the upper part of the small intestine and sucks the blood. The infective parasite is found in the excreta, by means of which the infection spreads.

Tuberculosis.—The dangers of infection with the tubercle bacilli is not peculiar to industries, although nowhere as much as in industries are all the conditions present for the infection and its spread as among such a large number of persons. Tuberculosis is so prevalent among workers, especially in dusty trades, that it may be called a disease of workingmen.

INDUSTRIAL ACCIDENTS AND HEALTH.

Occurrence.—While accidental injury to the worker may take place in every industry and trade, there are some trades which involve peculiarly **extrahazardous work** because of some of the conditions under which they are carried on. Thus,

workmen on high buildings, bridge workers, miners, and tunnel workers, manufacturers of explosives, workers in blast furnaces, iron, steel, and other metal makers, railroad men, chemical workers, and many other workers in many other industries are exposed to special dangers from accidents.

Besides the trades enumerated there are **special elements of danger** in all factories and establishments where any kind of machinery is used, the hazards due to the various wheels, belts, gears, saws, fly-wheels, knives, sharp edges, etc., of the machinery.

Varieties of Injury.—The accidental injuries vary in their extent and importance from slight burns, scalds, dislocations, bruises, wounds, injuries, fractures to loss of eye, limb, fracture of scull, and sudden death. The injuries may be slight, or they may lead to grave results, or may be fatal at once.

The amount of suffering, loss of work, and distress to families of workers is appalling.

Among the railroad employees there were in the United States not less than 53,046 killed while at work from the years 1888 to 1907, and more than 800,000 employees were either maimed or crippled.

The **number of accidents** in the various industries is enormous. According to Hoffman, there are nearly 2,000,000 accidents every year in the United States, of which 30,000 are directly fatal, while many of the others are followed by partial or total permanent disability of the injured workers.

Upon an analysis of the **causes of the various accidents** in industry, one may find that most of them may be due to one of the following causes: faulty construction of place of work or of implements; unguarded machinery; unremedied defects in construction, machinery, etc.; dangerous materials, explosives, etc.; inadequate and incompetent supervision; insufficient warning signals, etc.; too long hours of work, too great tension; overwork, fatigue, and overstrain; ignorance, youth, and inexperience of workers; criminal negligence of foremen, etc.; recklessness, carelessness, etc., of employees.

Almost all industrial accidents may be traced to one or more of the above causes enumerated, most of which are preventable and avoidable.

INDUSTRIAL PROPHYLAXIS.

Two Classes of Industrial Disease.—In the study of the ill-effects of industries on health, of the various adverse conditions incident to different trades, and of the manifold causes of industrial diseases, we find many of them necessary and unavoidable; but there are also many, if not most, which are not necessary, may be avoided, and are entirely preventable.

Some of the causes of industrial diseases lie not only in the unavoidable industrial processes and materials, but also in the ignorance and carelessness of the employees themselves, and more so in the greed, covetousness, false economy, and cruelty of the employers, who neglect the simplest health precautions and leave machinery and other devises unprotected because of the small cost, which is infinitesimal in comparison with the cost to the public health of the injuries and accidents due to them.

The **aim** and **purpose of industrial hygiene** is to abolish all preventable adverse industrial conditions, the ideal of hygiene being that industrial life should be a blessing to health and conducive to it, instead of harmful and injurious.

The demands of industrial hygiene, therefore, meet a twofold resistance on the part of the two classes in whose interest it should work, a resistance that may be overcome but in two ways: on the one hand, in the general education of the working people and the general public in the ill-effects of many industries and in the preventable nature of most of them; and, on the other hand, in compulsory legislation protecting the workingman against himself and especially against the effects of injuries caused by preventable elements, said legislation compelling the employers to put their plants and processes on a sanitary basis, with a view to save life and health.

The brief review of the prophylactic measures enumerated below includes measures which either are already embraced in the codes of industrial legislation in this or other countries, or such as are seriously discussed and are bound to become laws sooner or later in the progress of industrial hygiene.

SANITATION OF THE WORKPLACE.

The **construction of industrial establishments** should be definitely designed for the specific purposes to be carried on therein, and the common practice of having any ramshackle building fitted up for factory purposes should be prohibited.

The **size of the workplace** should correspond to the number of employees and to the peculiar needs of the establishment. The minimum of 400 cubic feet of space for every workman which is established by legislation in many places is inadequate in most industries unless there is a system of mechanical ventilation, otherwise the cubic feet space should be raised to at least 1000 cubic feet, and more, especially in dusty trades.

The **walls, floors, ceilings, and all other surfaces** in factories should be smooth, without crevices, nooks, corners, mouldings, etc., and should be finished with some non-absorbent, light-colored materials, easily washed off and cleansible. Whenever practicable, the floors are best made of concrete, tiles, or glass; this is especially necessary where mercury, lead, or other poisons are worked with and are liable to accumulate in crevices and rough surfaces of floors.

There should be ample provision for **water-supply fixtures,** for drinking purposes as well as for washing, which is an important prophylactic measure in dusty and poisonous trades. The washrooms, bathrooms, and toilet accommodations are usually provided separately for the male and female workers, and are put into apartments with tiled floors and walls.

Upon the proper **lighting facilities** depend not only the condition of the eyesight of the workers, but also their general

health. The ideal workplace is the one where any other illumination but that of sunlight is avoided; if artificial illumination is unavoidable, it should be electric light, as it produces the best light with the least impurities. Whenever artificial illumination is used it should be placed at proper distances from the workers, there should be a uniform distribution, and the light should not be too glaring and produce as little heat and impurities as possible.

Ventilation is the corner-stone of industrial hygiene; for by far the greatest part of the dangers which threaten workers are due to the impurities in the air of the workplaces. While natural ventilation may be sufficient for dwelling houses with the comparatively few persons in every room, it is insufficient and entirely inadequate in industrial establishments, even with all the artificial devices, openings for inlets and outlets that may be installed. Nothing short of mechanical ventilation should be allowed in any factory where a number of people work at any trade, especially one producing more or less dust. With the introduction of mechanical power, steam, water, and electricity, in almost all industrial establishments, there is no reason why every factory should not be provided with an efficient system of mechanical vacuum and plenum system of ventilation, to remove all dust and impurities in the air and bring in pure air from the outside. A good system of ventilation in factories would not only prevent the inhalation of air impurities, but would also promote the health of the workers and make them industrially more efficient.

Dust.—The prophylaxis of the injurious effects of dust may be summarized in the following measures:

1. **Separation of the dusty processes,** or trades, or part of trades from any other less dust-producing trades, and their concentration in special establishments, or in specially constructed rooms.

2. **Substitution of machinery for handwork** in all dusty processes, with the resulting decrease in the number of workers subject to dust, and with the possibility of better control of the dusty process.

3. **Substitution of the wet method** for the dry production; that is, all materials and processes producing dust should be well moistened during the process. This may easily be done in the filing, cutting, grinding, polishing, and similar dust-producing industries, with a consequent large elimination of dust.

4. **Isolation of the Worker from the Dust.**—This may be accomplished in several ways: (*a*) By separating the worker from the dust-producing machine, etc., by a glass or other wall or screen; (*b*) by protecting the nose and mouth of the worker by specially constructed "respirators," which are made properly adjusted to the face with a filtering medium catching the dust; (*c*) by enclosing the most dusty processes in tight rooms, the machinery, etc., of which is worked from the outside by electricity or tools handled from the outside.

5. **Instant and continuous removal of the dust** produced by special vacuum hoods and tubes covering every dust producing machine process, all dust being exhausted by a motor power operated from one central location, which by means of a series of ducts and tubes is connected with every worker's bench or machine.

One or more of these prophylactic measures must be employed in every dusty occupation, with resulting saving of life by preventing the ill-effects of dust upon health.

The **prophylaxis of industrial poisons, gases,** and **fumes** does not differ in its essential features from the prophylactic principles laid down for dusty occupations, except that they must be more strictly and carefully enforced. When dealing with poisons and gases, it is still more important to avoid all preventable conditions, in the use of the ingredients as well as in the various processes of production. There are certain poisonous materials which may be entirely eliminated from trades without any detriment to the trades; this is notably the case with the use of yellow phosphorus in match manufacture, in which it has been practically demonstrated that the substitution of the red phosphorus does not hurt the industry, produces a match of good quality, and absolutely does away with the dangers of phosphorous poisoning. The

same may apply to use of lead in pottery glaze, in which it has also been demonstrated that the use of leadless glazes is cheap, efficient, and without danger to health. This may also be applied to the use of lead in paints, in toys, the use of mercury in silvering mirrors, and the substitution of non-toxic elements and processes in many other industries. Nothing short of eliminating all toxic elements from all industries will satisfy hygiene, but industrial legislation should insist in prohibiting the use of any toxic substance which may be readily substituted by a non-poisonous one.

The removal of gases and fumes produced by appropriate machinery and ventilation is even more important than in the case of dust.

The **prophylaxis of industrial infection** from hair, hides, cloths, etc., consists in a thorough disinfection of all suspicious materials and proper precautions of the employees in handling such products and materials.

Industrial, Personal, and Other Prophylaxis.—The following are some of the essential measures necessary for the prevention of the ill-effects of industry upon health.

1. Proper supervision and control of selection of trade.
2. Manual training and education.
3. Personal cleanliness, etc.
4. Restriction of female labor.
5. Abolition of child labor.
6. Prohibition of home work.
7. Regulation of excessive temperature, humidity, etc.
8. Prevention of fatigue, overwork, etc.
9. Security of wages, rate of compensation, etc.
10. Prevention of accidental injuries, etc.
11. Medical factory inspection.
12. Public control of environmental conditions.
13. State insurance, etc.

1. The **selection of a trade,** which at present is so haphazard and without previous thought, should be better regulated, as upon it depends the subsequent influence of the industry upon the health. Persons of tuberculous tendencies should avoid dusty occupations, robust persons should select

strenuous occupations, while less robust should be assigned to inactive and less arduous work. There is no reason why factories and all industrial establishments should not subject the applicant to a rigid preliminary physical examination, the same as the State subjects the voluntary military recruit. This is already done in many civil service positions in State and municipal departments; also in many railroad and other transit systems, and if made a permanent policy in all trades, would assure a better and more efficient class of workers, as well as protect these against the effects of trade diseases.

2. The **preliminary manual training** of apprentices and applicants of trades in the science and art of their professions would be a great preventive against the ill effects of many industries by educating a class of workers well acquainted with their trades, with the processes and with the machinery used, as well as with the ordinary precautions to be used against any and all untoward influences in the trades.

3. The supervision of the **personal cleanliness** and **personal hygiene of the workers** should be part of the education of the workers themselves, should also be part of the duty of their employer, as well as a duty of the State factory inspectors.

The wearing of proper clothing, the compulsory washing of hands, and use of washrooms in all, especially in dusty and poisonous, occupations, the wearing of respirators when needed, the avoidance of alcoholic stimulation and other offensive habits, etc., are all matters of great importance to health; and until the workers are themselves educated to use these measures without compulsion, should be under the control of State authorities.

4. There is abundant legislation for the **restriction of female labor**, especially restriction of age, of work periods, of night work, of work during pregnancy, during convalescence after labor, etc. Such legislation is as yet very ununiform in various States and various places, very laxly observed in many industries, and should be more scientifically elaborated, made more uniform throughout the country, and rigidly enforced by factory inspection.

5. There are no reasons for **child work**; neither economic nor social, nor sanitary, and the consensus of opinion is that child labor is a curse and should be abolished in all civilized communities. No compromises should be made, and the age of beginning of any work, except educational, should be limited to *at least* sixteen years for males and eighteen for females.

6. **Home work** is prohibited at present by many States with regard to many industries, although it is still allowed, though to be licensed, in the clothing industry. A further restriction, or total prohibition, of home work would certainly be beneficial to health.

7. The **control of adverse conditions** in industries, as alluded to in a previous section, such as extremes in temperature, in light, humidity, etc., air pressure, are better studied each separately, and the prophylaxis is possible in many cases, and the ill-effects preventable in most cases by proper care, attention and installations of labor-saving and safety devices, the discussions of which cannot be gone into here.

8. The **prevention of the ill-effects of fatigue** consist in adjusting of the work to the capacity of each individual, in avoidance of too arduous tasks, of overestimating strength. in introduction of machinery in difficult labor, in shortening the hours of labor, in lengthening the pauses between labor periods, in the cessation of work during parts of day, parts of week, season and year, and in the avoidance of strain, tension, overwork, etc.

9. The **security of work and place**, the regulation of the rate of wages to the standard of living, and other conditions are matters of social-economic consideration rather than of hygiene, although they play such an important role in the effects of trades upon health.

10. The **prevention of accidents** by machinery or other causes is a science by itself. Most countries have enacted rigid laws for the protection of employees from machinery and to prevent accidents generally. Motors, engines, and fly-wheels may be fenced in and provided with proper guards and rails. Wheels, shafts, drums, belts, gearing, etc., may

be encased and protected by special devices. Special rules in each industry are necessary to prevent the elements of risk peculiar to each trade.

11. **Factory inspection** is already a recognized state institution, and has done much toward the amelioration of the conditions of labor. In order to increase the benefits of this institution part of the control of industries should be in the hands of qualified physicians. **Medical factory inspe tion** is a demand of modern industrial hygiene no less than medical school inspection. A comprehensive medical factory inspection embraces the following features: state licensing of trades and industrial establishments; preliminary physical examination of applicants for employment; periodical medical inspection and examination of workers; exclusion of all physically unfit, or suffering from incipient disease; sanitary inspection of places of trades and all sanitation. Medical factory inspection is already a fact in many European countries where its great benefit to public health has been already recognized.

12. The **public control of environmental conditions**, the improvements in the housing of the working classes, the spread of education, the better systems of popular nutrition, and similar sanitary improvements are already parts of the duties of social workers and public health progress.

13. Finally, the promotion of public health demands the institution of new measures for the protection of the workers, as well as the general community, by means of **compulsory industrial insurance.** Insurance against accidents, against sickness, against death, against unemployment, and similar insurance is already introduced in many countries, and the principle of it is rapidly spreading and promises to become a definite corner-stone of industrial legislation and welfare.

The effects of a comprehensive state insurance of industrial workers on public health would certainly be very great, and would be the best achievement of public hygiene.

QUESTIONS.

Define industrial hygiene.
Sum up the effects of occupation upon health.
Name the principal groups of factors causing industrial disease.
What are the effects of an unwise selection of trade?
To what are due the ill-effects of women labor?
To what are due the ill-effects of child labor?
What effect has the place of work upon health?
Name the various adverse industrial conditions.
What effects have extremes of temperature on health?
What effects have adverse conditions of humidity, light, and position?
What effects have variations of air pressure?
What is caisson disease, and what are its symptoms?
What are the ill-effects of fatigue?
What are the "fatigue neuroses"?
What is the effect upon health of constant dust inhalation?
Classify various trades according to kind of dust produced.
Name the "industrial poisons."
What is the effect of lead, acute, and chronic poisoning?
What are the symptoms of arsenical industrial poisoning?
What are the effects of mercury industrial poisoning?
What are the effects of phosphorus poisoning?
What injurious gases and fumes are found in industries?
What is the difference in the effects of poisons and gases?
In what trades is there danger of bacterial infection?
What are the common causes of industrial accidents?
What are the essential elements of a sanitary workshop?
What are essential elements in the prevention of effects of dust?
What are the prophylactic measures in toxic industries?
What are measures to prevent effects of gases and fumes?
What are elements of personal industrial prophylaxis?
What are the measures for preventing industrial infection?
What are the measures for preventing industrial accidents?
What are essential elements of medical factory inspection?
What are the forms of industrial State and private insurance?

CHAPTER V.

PUBLIC WATER SUPPLY.

Water Supply and Public Health.—One of the important branches of public hygiene is a consideration of the public water supply and its relation to public health, the dangers of impure water and the diseases due to them, and the means and methods of insuring the public a pure and abundant water supply for all purposes.

The consideration of the construction of reservoirs, aqueducts, filter plants, etc., is within the domain of sanitary art or engineering.

The **intimate relation of water to health** has been recognized from time immemorial. Important as are all the various impurities that are often found in water, the greatest importance, so far as health is concerned, is ascribed to the organic ingredients, and, especially, to the parasitic ova and to the pathogenic germs which may, at times, contaminate the water.

Of the **parasitic ova in water**, which, on ingestion by human beings, may develop and endanger health, the following are of the most importance: tænia solium, lata, etc.; oxyuris vermicularis, ascaris lumbricoides, filaria dracunculus, filaria sanguinis hominis, anchylostomum duodenale, bilharzia hematobia, distomum hæmatobimum, leeches, etc. The development and actions of these various parasites cannot be gone into here more particularly.

Pathogenic microbes in water may embrace all known kinds, although they differ much as to their virulence when in this medium, as to their viability, and as to the influence of the water on them.

The specific microörganisms of diphtheria, tuberculosis, tetanus, anthrax, malignant edema, and others have been

demonstrated at different times in water, but their action and influence on human health have as yet not been exactly defined or demonstrated.

The most important microörganisms which have been found in water, and to which the so-called "**water-borne diseases**" are due, are the pathogenic germs of cholera, typhoid, dysentery, "Weil's" disease, and some gastro-intestinal affections.

The connection of dysentery, malaria, goitre and cretinism, yellow fever, and other diseases with drinking water has been urged and claimed by a number of investigators, although it has not as yet been possible to successfully demonstrate their exact relations.

The causation of gastro-intestinal disease by drinking water has been fully proved, although the exact germ to which it may be due has as yet not been fully agreed upon.

The connection between water and malignant edema, tetanus, anthrax, have been fully demonstrated and proved to be due to the ingredients of animal excreta contaminating water.

The greatest achievements of sanitary science have been the complete and practical demonstration of the causative relations between impure drinking water and cholera and typhoid fever.

Water Supply and Cholera.—In his classic essay, "On the Mode of Communication of Cholera," published in 1855, Dr. Snow was the first to show the relation of cholera to drinking water, long before the specific microbe of cholera had been discovered by Robert Koch (1884).

In the frequent marches of the dread Asiatic cholera from its birthplace in the East through the highways and byways of Europe it was noticed that certain towns and places were invariably spared, and on examination it has always been found that such places received their water supply from separate sources not connected with other places.

In the six epidemics through which the city of Halle went it was found that one quarter of the city enjoying a separate water supply from springs invariably escaped the epidemic.

In the London epidemic, in 1849, when the whole city was supplied by two companies with water from the Thames, the whole city suffered equally, while in the epidemic of 1854, when one part of the city was supplied by one company from a more distant part of the river, while the other part of the city was supplied from the old source, it was found that the part of the city supplied from the new source suffered three and a half times less than the part supplied from the old source.

But the clearest and most valuable proof was found in the London epidemic of 1854, when it was found that the mortality in one particular parish—that of St. James—was at the rate of 220 per 10,000, while in the immediately adjoining parishes it was but at the rate of 9 and 33 per 10,000. In that same St. James parish, in the epidemic of 1849, the mortality was but 15 per 10,000.

Upon a most painstaking and thorough investigation it was discovered that the infection was due to one contaminated well in Broad Street, a pump into which drained an open cesspool, or privy, from an adjoining house, which privy was clearly contaminated by the cholera germs, at that time not yet discovered. In Broad Street, not distant from the place where the cholera cases were developing daily, there was a brewery, with seventy workmen, who enjoyed entire immunity, but they were supplied with drinking water from a special well within the brewery.

The case of Hamburg is no less classical, and often quoted. In 1892 there was in Hamburg an epidemic of cholera lasting four months, but while one section of the city was infected and numerous cases were cropping out daily, the adjoining part of Hamburg, called Altoona, which enjoyed a separate water supply from the same river, the Elbe, *but which was filtered,* was comparatively free from the ravages of the epidemic.

In 1884 it was at last possible for Robert Koch to demonstrate the cholera comma bacillus in the infected wells of a cholera district in Calcutta, and since then the etiological relation of water and cholera was established beyond dispute.

More important, because of the greater frequency and the endemic character of typhoid fever, is the clear proof of the **relation of drinking water and typhoid fever.**

The epidemics of typhoid in Lauzanne, Switzerland, in 1872; in Red Hill, England; in Plymouth, Pa., in 1885; in Lowell and Lawrence, Mass.; in Ithaca, N. Y.; in Philadelphia, are commonly quoted as examples of the demonstrated effects of polluted water supplies in the causation of typhoid fever.

What may be accomplished by a purified water supply was demonstrated by the city of Lawrence, Mass., which reduced its death rate from typhoid from 10 to 12 per 10,000, before 1893, to almost 0 after installing an efficient filtering plant.

Source of Infection of Water Supply.—The water-borne diseases come from the germs found in drinking water; but whence come the germs? What is their source?

Chemically pure water is rarely found except in the chemist's flask. Being a universal dissolvent and diluent, water almost always contains some organic or inorganic matter suspended or diluted in it. Even rain water, which is pure before it comes within the ground atmosphere, immediately takes up any impurities with which it comes into contact during its fall upon the ground.

It is obvious that surface water as well as subsoil water are still more contaminated than rain water, the media through which they go imparting to the water a large part of their constituents. Indeed, there are hardly any sources of water which may not be causes of water contamination with various impurities.

The most important matter which often contaminates the water supply is sewage, human and animal excreta, which are commonly deposited upon the ground, thrown into waters, and are well mixed with almost all waters on the surface, as well as near the subsurface of the ground. Hence it is nearly always the case that all sources of water supply are more or less contaminated with sewage matter.

As the pathogenic microbes of typhoid fever, cholera, dysentery, various gastro-intestinal diseases are commonly found

in the excreta of diseased persons, the pollution of drinking water with such excreta is clearly the cause of the "water-borne diseases" and epidemics.

Sources of Public Water Supply.—The common sources of water supply in small communities, rural locations, and individual farms are obviously inadequate for large communities and big cities, with their hundreds of thousands and millions of population.

Large fresh-water lakes and rivers on which cities are situated have at times been relied on for water supply, but as the same rivers and lakes have been commonly used as dump-grounds for waste from factories, and for the huge quantities of sewage matter produced by those cities, it is evident that such a public water supply becomes a menace to the health of the population by the great contamination of the water and by consequent increase in the death rate from typhoid fever and other water-borne diseases in those cities. This was actually the case in Chicago, Lawrence, Mass., Philadelphia, and many other cities which received their drinking water from such sources, and in which cities the increasing typhoid fever mortality compelled them to seek for better methods of public water supply.

The public water supply sources relied on by many cities are the natural or artificial water reservoirs, or collections of surface waters, rivers, streams, lakes, and ponds, which may be at some distance from the towns, and which may be fed by natural springs and by the natural rainfall. Such sources may be at great distances from the towns which they supply, as is the case with the Croton water supply of New York City, and still more with the newly projected Catskill watersheds and ducts, which are hundreds of miles from the city they are to supply.

The construction and maintenance of the water sheds, reservoirs, dams, aqueducts, and other parts of the public water supply system are within the province of the sanitary engineer. The health authorities, however, of the towns have a direct interest, and it is their duty to supervise the sanitation of the watershed country and the prevention of sources of

contamination of the supply system. Such a prevention of contamination demands the proper disposal of the sewage of the places about the water supply sheds and the preventing of the employees and other persons having charge of the various waterworks from depositing their excreta in a manner which may pollute the surface near the water sources.

But the most rational, the most effective, and therefore the most hygienic method of insuring a pure water supply, aside from the already noted means, is the public water purification.

Public Water Purification.—The means for purification of public water supplies are the following: storage and sedimentation, chemical treatment, and filtration.

Sedimentation.—A part of the impurities in the water may be removed therefrom by storing the water in basins where the suspended matter sinks by the action of gravity, and in the process of settling entangles other impurities, as well as some of the bacteria in the water. In order to get good results the basins must be shallow, the water left undisturbed, and the accumulated sediment removed from time to time. No complete reliance can be put on this method of water purification, as it does not guarantee a germ-free water.

Chemical Purification.—The sedimentation of water in the basins may be hastened by the addition to the water of certain chemicals, which act as coagulants and form precipitates, entangling the organic impurities and bacteria, thus freeing the water from a large part of them. The sulphate of aluminum, or alum (half a grain to the gallon), is used as such coagulants. Other chemicals used for water purification are chlorine, bromine, copper sulphate, metallic iron, ozone, sodium bisulphate, etc.

Neither sedimentation nor chemical purification are practicable for large water supplies, nor are they free from many objections.

Filtration.—The only method which has proved successful in providing a pure water supply is filtration.

Filtration on a large scale was first introduced by John Simpson, in London, in 1829, and it was at first thought to

act only mechanically, but it has since been proved that its action is also largely biological.

Filtration of large quantities of water is accomplished by means of sand beds of large area, the sides and bottoms of which are concreted, and on the bottom of which are placed numerous perforated and open drains which are to lead off the filtered water into separate special reservoirs. On the bottom of the filter areas, which are usually half or an acre in size, is placed a layer of coarse gravel, upon this a layer of finer gravel, which is then covered by a layer of fine, sharp sand, several feet in thickness, the whole filtering medium being from 4 to 6 feet in thickness. The filter is at first filled from beneath so that all air be driven off, and the filter area is then filled to a level of several feet above the filter bed. A filter of an acre in area may be made to filter two to four millions of gallons of water in twenty-four hours. Such filters act not only mechanically in intercepting all suspended impurities, but the slimy sheet which soon covers the top layer of the sand acts biologically upon the water and destroys a large number of bacteria, so that, it is claimed, the water may be freed from 99 per cent. of its bacteria, provided the rate of filtration is not too rapid and the top of the sand-layers is scraped off half an inch from the surface from time to time.

In cold climates such filters are protected from freezing by the provision of permanent covers.

According to Robert Koch, a filtered water which contains more than 100 bacteria to the cubic centimeter should be rejected.

When the filtration of the water is done, instead of in large filter beds, in iron or wood cylinders filled with coarse sand, and the water is driven through the cylinders under pressure and a great deal faster than in large filters, the process is called mechanical filtration. It is usually assisted by application of alum. The whole process is essentially different from common sand filtration, and is not suitable to the water supplies of many cities.

QUESTIONS.

Name the parasitic ova that may be found in water, and state their effects on health.

What pathogenic bacteria may be found in water?

What are the special relations of typhoid and cholera infection and drinking water?

Name the various sources of public water supply.

What are the principal dangers to the sources of public water supply?

What are the methods of purification of public water supply?

Describe the advantages and process of sand filtration.

Describe a system of mechanical filtration.

CHAPTER VI.

FOOD SUPPLY.

Public food supply and public health are intimately connected because of the dangers to health of impure foods, and the subject is therefore a part of public hygiene.

The chemical constituents of the various foods, the theory and practice of nutrition, and the subject of dietetics belong to the domain of chemistry, physiology, and individual hygiene, while public hygiene deals with the effects of impure food supplies upon public health.

Classification of Foodstuffs.—According to the importance of the foods we may arbitrarily classify all foods into three broad divisions: meats and meat products; cereals, nuts, fruits, vegetables, etc.; and milk and milk products. The special dangers to health of meats and of milk justify us in treating these foods at length, while but briefly alluding to the others.

I. MEAT FOODS.

The **hygiene of meat foods** may be considered according to the following subdivisions:

Dangers to Health: Infection by entozoa, infection by bacteria, toxins, and ptomains.

Etiology: Diseases of the animals, condition of the animals, postmortem changes, postmortem infection, adulteration.

Prophylaxis: Hygiene of the food animals: meat inspection, antemortem and postmortem; hygiene of place and persons; preservation, sanitary supervision of manufacture, etc.

Dangers to Health.—The dangers to health from the ingestion of flesh foods are due to infection by entozoa, infections by bacteria, and to the action of toxins and ptomains.

The **parasitic diseases due to meat** are caused by (1) infection by tapeworms, (2) infection by trichina, and (3) infection by echinococci.

Tapeworm.—The two principal species of tapeworm found in man which are due to meat infection are the *tænia saginata* and the *tænia solium;* the former is due to infection by "measly" beef, the latter by "measly" pork.

The "*cysticercus cellulosæ*" is the larval form of the *tænia solium,* and is found in hogs, in which it appears as minute bladder worms, encased in little cysts which are found in the intestines, muscular fibers, brain, liver, and other parts, and especially under the tongue, where it may readily be recognized. The cysticercus is derived from the segment and egg of the *tænia solium,* which are passed from the human intestine, ingested by the hog, and on reingestion by man are redeveloped into tenia.

The *cysticercus bovis* is the larval form of the *tænia saginata* of man, and is found in the intermuscular fibers and connective tissue of cattle.

The **trichina spiralis** is a parasite found mostly in the muscular fibers of pork, in the form of minute spiral-form worms, which are encapsulated, but may be recognized with the naked eyes as white specks. The ingestion of pork infected by trichina causes in man the disease called "**trichinosis,**" an acute disease due to the presence of the trichina in the muscular fibers, and the symptoms of which resemble typhoid fever. The disease is often fatal.

Echinococcus sometimes infects sheep, and, rarely, cattle, and the meat causes in man the hydatid diseases. Originally the infection comes from the *tænia echinococcus* found in dogs.

Meat Infection by Bacteria.—Pathogenic bacteria may be found in the flesh of animals, and is capable of producing disease in man on eating the infected meat. The pathogenic bacteria may originate in the diseased condition of the live animals suffering from the infectious diseases, or the pathogenic germs may gain entrance into the meat of healthy animals through infection by contact, etc., after killing.

The **diseases of animals infectious to man** which are caused by pathogenic bacteria and which, it is claimed, may be transmitted through their meat to man, are the following: Tuberculosis, pleuropneumonia, foot and mouth disease, cattle plague, anthrax, glanders, malignant edema, erysipelas, actinomycosis, typhoid fever, cholera, pyemia, septicemia, tetanus, sheep-pox, Texas fever, etc.

Toxins and Ptomains.—Certain meat causes on ingestion toxic symptoms. These symptoms are due to substances in the meat which are toxic, or to bacterial products of decomposition, called "ptomains." The symptoms resemble those of severe gastro-intestinal inflammation, and may be fatal. The *bacillus botulinus* and others have been regarded as causing some of the toxic influences of certain meats.

The virulence of the intoxication by meat differs according to the condition of meat, the manner of preparation, the quantity ingested, and the individual idiosyncrasies of the victim.

The most frequent cases of intoxication are caused by the eating of "prepared meats," such as chopped meats, sausages, canned, "potted," and "deviled" meats, etc.

The **causes of the unfitness of meat for food** may be due to: (1) Diseases of animals; (2) unfit condition of living animals; (3) postmortem changes; (4) infection of the meat by persons or by places of manufacture, sale, etc.; (5) adulteration.

The **diseases of food animals** which render their meat totally or partly unfit for food have been enumerated above, and will be mentioned again in the section on meat inspection.

The **condition of the food animals** which may render their meat unfit for food are the following:

1. Death of animal from age, disease, or accident.
2. Moribund condition from injury, drugs, overwork, fright, overdriving, etc.
3. Immature animals, unborn calves and lambs, and such as are in the first few weeks of life.
4. Artificial conditions and treatment of the carcass by blowing up (blown veal), coloring, etc.

Postmortem Changes.—The temperature and moisture and substance of the slaughtered carcass make it the best medium for the development and life of the swarming microörganisms present in the meat and such as may gain access later. The resulting decomposition and organic changes are bound to deteriorate the flesh so as to render it unfit for food unless bacterial action is inhibited; that is, unless the meat is put into a condition rendering the development of bacteria and putrefaction unfavorable. The rapidity with which the meat deteriorates depends on the condition of the animal from which it is obtained, the cleanliness of the process of preparation, and the place in which it is kept.

Infection by Persons and Places.—In addition to all the foregoing sources of deterioration, meat may be directly infected with pathogenic and other bacteria by the many persons who handle and who take part in the slaughtering, skinning, dressing, cutting, manufacturing, packing, etc., of the meat and its products.

The infection of the food may also be received from the various places through which the meat must pass in the various processes of manufacture.

Adulteration.—By "adulteration" is meant the changing, or altering of the normal composition, constitution, or appearance of the food. Adulteration is often dangerous to health by the changes in the normal constitution of the food, or it may be simply fraudulent in substituting partly or wholly less expensive substances for the more costly.

Meat adulterations may consist in:

1. Addition of foreign substances reducing, lowering, or injuring the quality of the food.
2. Partial or entire substitution of an inferior substance.
3. Extraction of some of the valuable substance from the meat.
4. Coloring, coating, or otherwise changing the appearance of the food, whereby poor quality is concealed, or it is made to look better than it is.
5. Addition of some foreign substance to "preserve" it.

Prophylaxis.—The means of preventing the injurious effects of unfit, bad, and infected meats are the following:

1. Sanitary care for food animals.
2. Meat inspection (antemortem and postmortem).
3. Sanitation of places and persons.
4. Preservation, or destruction of infective agents.
5. Sanitary supervision of manufacture and sale, etc.

Sanitary Care for Food Animals.—The housing, feeding, and care of the domestic animals which are to be rendered as food is of much importance to their health, and consequently to the health of the persons for whose food they are intended.

The construction of cattle pens, stables, barns, and other places intended for keeping animals must follow the rules guiding all construction of shelters from rain, storms, and extremes in climates.

Abundant sources of natural light, in the form of windows and skylights, must be provided in every stable, barn, etc.

From 7000 to 10,000 cubic feet of air are needed per hour for cows and horses, and, therefore, the change of air in the barns and stables must be frequent and abundant.

Ventilation of stables, etc., may be had through openings in windows, skylights, or special inlets and outlets designed for the purpose.

In very cold places the stables, etc., should be artificially heated during winter.

Plenty of pure water should be provided for drinking purposes, as well as for washing and cleansing.

The drainage of the stables, etc., must be carefully planned, so as to immediately remove all liquid urine and manure from under the stall and flush away all liquids into properly trapped and sewer-connected drains.

The walls and ceilings should be constructed of some nonabsorbent material easily cleaned and washed, while the floors must invariably be made of cement, concrete, or tile, or stones set in cement, and the floor be properly graded, so as to drain all liquids into the drain, while at the foot of every

stall an iron valley drain, properly covered, provided for the draining of all urine and liquids.

All manure and refuse should be collected several times daily, packed in proper receptacles, and removed from the premises.

The animals need daily exercise, fresh air, and should be washed and scrubbed at periodical intervals.

Daily grazing in fields during milder weather is necessary for the animal's health, as well as the provision for its proper feeding with cornmeal and other appropriate foods.

Inspection and examination by competent veterinarians is periodically necessary to discover incipient disease and to isolate diseased cattle from the herd.

Tuberculin tests should be made at periodical intervals, and all diseased cattle condemned and destroyed.

Care must also be taken of the animals during their transportation in cars, in the cattle pens where they are exposed for sale, as well as in the pens where they are kept before slaughter.

The **sanitation of packing houses and factories** where the meat is transformed into the various articles of commerce is supervised by federal, state, and municipal authorities, and the following extracts from Regulation 11 of the Federal Meat Inspection Law (B. A. I., No. 137) will illustrate the principal points:

"(*a*) Ceilings, side walls, pillars, partitions, etc., shall be frequently whitewashed or painted, or, where this is impracticable, they shall, when necessary, be washed, scraped, or otherwise rendered sanitary. . . . All floors upon which meats are piled during the process of curing shall be so constructed that they can be kept in a clean and sanitary condition, and such meats shall also be kept clean.

"(*b*) All trucks, drays, and other receptacles, all chutes, platforms, racks, tables, etc., and all knives, saws, cleavers, and other tools, and all utensils and machinery used in moving, handling, cutting, chopping, mixing, canning, or other process shall be thoroughly cleansed daily, if used.

"(*c*) The aprons, smocks, or other outer clothing of employees who handle meat in contact with such clothing shall be of a material that is readily cleansed, and shall be cleansed daily, if used. Employees who handle meats or meat food products shall be required to keep their hands clean.

"(*d*) All toilet rooms, urinal, and dressing rooms shall be entirely separated from compartments in which carcasses are dressed or meat foods are cured, stored, packed, handled, or prepared. They shall be sufficient in number, ample in size, and fitted with modern lavatory accommodations, including toilet paper, soap, running water, towels, etc. They shall be properly lighted, suitably ventilated, and kept in a sanitary condition.

"(*e*) The rooms and compartments in which meat and meat products are prepared, or otherwise handled, shall be lighted and ventilated in a manner acceptable to the inspector in charge, and shall be so located that odors from toilet rooms, catch basins, casing departments, tank rooms, hide cellars, etc., do not permeate them.

"(*f*) Persons affected with tuberculosis or other communicable disease shall not be knowingly employed in any department of the establishments where carcasses are dressed, meats handled, or meat food products prepared, and any employee suspected of being so affected shall be so reported by the inspector in charge.

"(*j*) Meats and meat food products intended for rendering into edible products must be prevented from falling upon the floor, while being emptied into the tanks, by the use of some device, such as a metal funnel.

"(*l*) Carcasses or parts thereof inflated with air blown from the mouth shall not be passed.

"(*m*) Carcasses dressed with skewers that have been held in the mouth shall not be passed."

The foregoing are some of the rules to render the manufacturing of meat-food products more sanitary and to keep the personnel and places in a sanitary condition.

II. ANTEMORTEM AND POSTMORTEM MEAT INSPECTION.

The following is an extract from the official Regulations of the United States Department of Agriculture as embraced in Regulations 13, 14, 15:

"**Antemortem Examination and Inspection of Meat.**—An antemortem examination and inspection shall be made of all cattle, sheep, swine, and goats about to be slaughtered before they shall be allowed to enter an establishment at which inspection is maintained. Said examination and inspection shall be made in the pens, alleys, or chutes of the establishment at which the animals are about to be slaughtered. The proprietors of the establishments at which the said antemortem inspection is conducted shall provide satisfactory facilities for conducting said inspection and for separating and holding apart from healthy animals those showing symptoms of disease.

"All animals showing symptoms or suspected of being affected with any disease or condition which, under these regulations, would probably cause their condemnation when slaughtered, shall be marked by affixing to the ear or tail a metal tag.

"All such animals, except as hereinafter provided, shall be slaughtered separately, either before regular slaughter has commenced or at the close of the regular slaughter, and shall be duly identified by a representative of the establishment to the inspector on duty on the killing floor before the skins are removed or the carcasses opened for evisceration,

"Animals which have been tagged for pregnancy and which have not been exposed to any infectious or contagious disease are not required to be slaughtered, but before any such animal is removed from the establishment the tag shall be detached by a Department employee and returned with his report to the inspector in charge.

"If any pathological condition is suspected in which the question of temperature is important, such as Texas fever,

anthrax, pneumonia, blackleg, or septicemia, the exact temperature should be taken. Due consideration, however, must be given to the fact that extremely high temperatures may be found in otherwise normal hogs when subjected to exercise or excitement, and a similar condition may obtain to a less degree among other classes of animals. Animals commonly termed "downers," or crippled animals, shall be tagged, as provided for in Regulation 20, in the abattoir pens for the purpose of identification at the time of slaughter, and shall be passed upon in accordance with these regulations.

"**Postmortem Inspection of Meat at Time of Slaughter.**—The inspector or his assistant shall, at the time of slaughter, make a careful inspection of all animals slaughtered. The head, tail, thymus gland, bladder, caul, and the entire viscera, and all parts and blood used in the preparation of meat food products shall be retained in such manner as to preserve their identity until after the postmortem examination has been completed, in order that they may be identified in case of condemnation of the carcass. Suitable racks or metal receptacles shall be provided for retaining such parts.

"Carcasses and parts thereof found to be sound, healthful, wholesome, and fit for human food shall be passed and marked as provided in these regulations.

"Should any lesion of disease or other condition that would probably render the meat or any organ unfit for food purposes be found on postmortem examination, such meat or organ shall be marked immediately with a tag, as provided in Regulation 27. Carcasses which have been so marked shall not be washed or trimmed unless such washing or trimming is authorized by the inspector.

"**Disposal of Diseased Carcasses and Organs.**—The carcasses or parts of carcasses of all animals which are slaughtered at an establishment where inspection is maintained, and which are found at time of slaughter or at any subsequent inspection to be affected with any of the diseases or conditions named below shall be disposed of according to the section of this regulation pertaining to the disease or condition. It is to be understood, however, that owing to the fact that it is imprac-

ticable to formulate rules covering every case, and to designate at just what stage a process becomes loathsome or a disease noxious, the decision as to the disposition of all carcasses, parts, or organs not specifically covered by these regulations shall be left to the veterinary inspector in charge. Carcasses found, before evisceration has taken place, to be affected with an infectious or contagious disease, including tuberculosis, shall not be eviscerated at the regular killing bed or bench, but shall be taken to the retaining room, or other specially prepared place, separate from other carcasses, and there opened and examined.

"(*a*) *Anthrax, or Charbon.*—All carcasses showing lesions of this disease, regardless of the extent of the disease, shall be condemned and immediately tanked, including the hide, hoofs, horns, viscera, fat, blood, and all other portions of the animal. The killing bed upon which the animal was slaughtered shall be disinfected with a 10 per cent. solution of formalin, and all knives, saws, cleavers, and other instruments which have come in contact with the carcass shall be treated as provided in Regulation 11, paragraph (*h*), before being used upon another carcass.

"(*b*) *Blackleg.*—Carcasses of animals showing lesions of blackleg shall be condemned.

"(*c*) *Hemorrhagic Septicemia.*—Carcasses of animals affected with this disease shall be condemned.

"(*d*) *Pyemia and Septicemia.*—Carcasses showing lesions of either of these diseases shall be condemned.

"(*e*) *Rabies.*—Carcasses of animals which showed symptoms of rabies before slaughter shall be condemned.

"(*f*) *Tetanus.*—Carcasses of animals which showed symptoms of tetanus before slaughter shall be condemned.

"(*g*) *Malignant Epizoötic Catarrh.*—Carcasses of animals affected with this disease and showing generalized inflammation of the mucous membranes shall be condemned.

"(*h*) *Hog Cholera and Swine Plague.*—(1) Carcasses showing well-marked and progressive lesions of hog cholera or swine plague in more than two of the organs (skin, kidneys, bones, or lymphatic glands) shall be condemned.

"(2) Carcasses showing slight lesions which are confined to the kidneys and lymphatic glands may be passed.

"(3) Carcasses which reveal lesions more numerous than those described for carcasses to be passed, but not so severe as the lesions described for carcasses to be condemned, may be rendered into lard, provided they are cooked by steam for four hours at a temperature not lower than 220° F.

"(4) In inspecting carcasses showing lesions of the skin, bones, kidneys, or lymphatic glands, due consideration shall be given to the extent and severity of the lesions found in the viscera.

"(*i*) *Actinomycosis, or Lumpy Jaw.*—1. If the carcass is in a well-nourished condition and there is no evidence upon post-mortem examination that the disease has extended from a primary area of infection in the head, the carcass may be passed, but the head, including the tongue, shall be condemned.

"2. If the carcass is in a well-nourished condition and the disease has extended beyond the primary area of infection, the disposition shall be made in accordance with the regulations relating to tuberculosis.

"(*j*) *Caseous Lymphadenitis.*—When the lesions are limited to the superficial lymphatic glands or to a few nodules in an organ, involving also the adjacent lymphatic glands, and the carcass is well nourished, the meat may be passed after the affected parts are removed and condemned. If extensive lesions, with or without pleuritic adhesions, are found in the lungs, or if several of the visceral organs contain caseous nodules and the carcass is emaciated, it shall be condemned.

"(*k*) *Tuberculosis.*—All carcasses affected with tuberculosis and showing emaciation shall be condemned. All other carcasses affected with tuberculosis shall be condemned, except those in which the lesions are slight, calcified, or encapsulated, and are confined to the tissues indicated in any one of the following five paragraphs, or to a less number of such tissues, and excepting also those which may, under paragraphs (6) and (7) below, be rendered into lard or tallow.

"1. The cervical lymphatic glands and two groups of visceral lymphatic glands in a single body cavity, such as the cervical, bronchial, and mediastinal glands, or the cervical, hepatic, and mesenteric glands.

"2. The cervical lymphatic glands and one group of visceral lymphatic glands and one organ in a single body cavity, such as the cervical and bronchial glands and the lungs, or the cervical and hepatic glands and the liver.

"3. Two groups of visceral lymphatic glands and one organ in a single body cavity, such as the bronchial and mediastinal glands and the lungs, or the hepatic and mesenteric glands and the liver.

"4. The cervical lymphatic glands and one group of visceral lymphatic glands in each body cavity, such as the cervical, bronchial, and hepatic glands.

"5. Two groups of visceral lymphatic glands in the thoracic cavity and one group in the abdominal cavity, or one group of visceral lymphatic glands in the thoracic cavity and two groups in the abdominal cavity, such as the bronchial, mediastinal, and hepatic glands, or the bronchial, hepatic, and mesenteric glands.

"6. Carcasses affected with tuberculosis, in which the lesions of the disease are located as described in any one of the preceding five paragraphs, but are slight and in a state of caseation, or liquefaction necrosis, or surrounded by hyperemic zones, and also those in which slight, calcified, or encapsulated lesions are found in more visceral organs or more groups of visceral lymphatic glands than are specified in any one of the preceding five paragraphs, may be rendered into lard or tallow after the diseased parts are removed. The carcasses shall be cooked by steam at a temperature not lower than 220° F. for not less than four hours.

"7. Carcasses in which the cervical lymphatic glands, one organ, and the serous membrane in a single body cavity, such as the cervical lymphatic glands, the lungs, and the pleura, or the cervical lymphatic glands, the liver, and the peritoneum, are affected with tuberculosis, may be rendered into lard or tallow after the diseased parts are removed. The

carcasses shall be cooked by steam at a temperature not lower than 220° F. for not less than four hours.

"8. All condemned carcasses, parts of carcasses, or organs showing lesions of tuberculosis shall be deposited in receptacles provided for that purpose, and shall either be tanked at once or be locked in the "condemned" room until such time as an employee of the Department can see that they are placed in the tank.

"9. All heads and other parts showing lesions of tuberculosis shall be condemned.

"(*l*) *Texas Fever.*—Carcasses showing sufficient lesions to warrant the diagnosis of Texas fever shall be condemned.

"(*m*) *Parasitic Icterohematuria.*—Carcasses of sheep affected with this disease shall be condemned.

"(*n*) *Mange, or Scab.*—Carcasses of animals affected with mange, or scab, in advanced stages, shall be condemned. When the disease is slight, the carcass may be passed.

"(*o*) *Tapeworm Cysts.*—Carcasses of animals slightly affected with tapeworm cysts may be rendered into lard or tallow, but extensively affected carcasses shall be condemned.

"(*p*) *Pneumonia, Pleurisy, Enteritis, Peritonitis, and Metritis.*—Carcasses showing generalized inflammation of one of the following tissues—the lungs, pleuræ, intestines, peritoneum, or the uterus—whether in acute or chronic form, shall be condemned.

"(*q*) *Icterus.*—Carcasses showing an intense yellow or greenish-yellow discoloration after proper cooling shall be condemned. Carcasses which exhibit a yellowish tint directly after slaughter, but lose this discoloration on chilling, may be passed for food.

"(*r*) *Uremia and Sexual Odor.*—Carcasses which give off the odor of urine or a strong sexual odor shall be condemned.

"(*s*) *Urticaria, etc.*—Hogs affected with *urticaria* (*diamond skin disease*), *tinea tonsurans*, *demodex folliculorum*, or *erythema* may be passed after detaching and condemning the skin, if the carcass is otherwise fit for food.

"(*t*) *Melanosis, etc.*—Carcasses of animals showing any disease or injury, such as traumatic pericarditis, generalized melanosis, pseudoleukemia, etc., which causes considerable elevation of temperature or affects the system of the animal, shall be condemned.

"(*u*) *Bruises, Abscesses, Liver, Flukes, etc.*—Any organ or part of a carcass which is badly bruised or which is affected by malignant tumors, abscesses, suppurating sores, or liver flukes shall be condemned, but when the lesions are so extensive as to affect the whole carcass, the whole carcass shall be condemned.

"(*v*) *Emaciation and Anemia.*—Carcasses of animals too emaciated or anemic to produce wholesome meat and those carcasses which show a slimy degeneration of the fat or a serous infiltration of the muscles shall be condemned.

"(*w*) *Pregnancy and Parturition.*—Carcasses of animals in advanced stages of pregnancy (showing signs of preparation for parturition), also carcasses of animals which have within ten days given birth to young and in which there is no evidence of septic infection, may be rendered into lard or tallow if desired by the manager of the establishment; otherwise they shall be condemned.

"(*x*) *Immaturity.*—Carcasses of animals too immature to produce wholesome meat, all unborn and stillborn animals, also carcasses of calves, pigs, kids, and lambs under three weeks of age shall be condemned.

"(*y*) *Diseased Parts.*—In all cases where carcasses showing localized lesions of disease are passed or rendered into lard or tallow, the diseased parts must be removed before the "U. S. Retained" tag is taken from the carcass, and such parts shall be condemned.

"(*z*) *Careless Scalding.*—Hogs which have been allowed to pass into the scalding vat alive shall be condemned.

"(*aa*) *Dead Animals.*—All animals that die in abattoir pens, and those in a dying condition before slaughter, shall be tagged as provided in Regulation 21, and in all cases shall be condemned. In conveying animals which have died in the pens of an establishment to the tank they shall not be

allowed to pass through compartments in which food products are prepared. No dead animals shall be brought into an establishment for rendering from outside the premises of said establishment."

III. MEAT PRESERVATION.

Characteristics of Good Meat.—Good meat is uniform in color, neither too red nor too pale, firm and elastic to the touch, moist but not wet; does not pit, nor crackle on pressure, and has a marbled appearance. It is free from unpleasant odor, its juices slightly redden litmus paper, the fat is firm and does not run. Beef is bright red, more marbled than any other meat. Veal is pale and less firm to the touch. Mutton is dull red, firm, and its fat white or yellowish. Horse meat is coarse in texture, dark in color, without layers of fat in the muscles; the fat is yellowish and runs down in drops when the carcass is hung up, and has a peculiar sweetish odor and taste.

Preservation of Meat.—To preserve meats from undergoing the postmortem putrefactive changes due to development of bacteria the following conditions are necessary: (1) Prevention of infection of the meat by microörganisms from places and persons; (2) storage of meat under such conditions as are unfavorable for the life and development of bacteria; and (3) destruction of all microörganisms in the meats.

The first condition of **prevention of meat infection** may be attained by rigid asepsis and cleanliness, as already indicated in the description of the sanitation of persons and places where the meat is produced and rendered into food products.

Storage of Meat.—The conditions which render the life and development of organic germs difficult, or entirely impossible, are the following: cold, dryness, and condimental, or part chemical preservation.

The third method is absolute **destruction of all germs,** *i. e.*, sterilizing it by means of heat.

Cold storage of meat does not kill bacteria, but inhibits their action, and keeping meat in cold storage, or freezing it,

may preserve the meat for quite a long time. However, the opinion that keeping of meat in cold storage may be prolonged indefinitely is wrong, as meat certainly deteriorates if kept longer than two or three months at low temperature. Frozen meats deteriorate very rapidly on being thawed, and have been known to produce toxic symptoms on ingestion. As an auxiliary means of preservation for not too prolonged periods cold is a valuable preservative.

Drying of meat is an old method of preserving it, and may be a valuable means of preserving the meat fibers, when rendered very dry, or in form of powders. The drying may be accomplished in the sun, and is very slow, or it may be done artificially. Its usefulness is necessarily limited.

Condimental preservation of meat consists in preserving it by the aid of salt, sugar, vinegar, and other condiments, either in dry form (with salt) or by the wet process (pickling in vinegar, etc.). These condiments do not kill the bacteria, but they effectively stop putrefaction and may preserve certain meats for long periods.

Smoking meat renders it not only comparatively dry but also impregnates it with the creosote of the smoke, which serves as a valuable means of preservation of certain kinds of meat.

None of the above methods of preservation destroys parasitic ova, or all the pathogenic germs which may be in the meat, and, excepting cold, all of them render the meat less digestible, and somewhat altered in the texture, appearance, and taste.

The use of **chemical preservatives**, such as borax, boracic acid, sulphite of soda, and others, is very reprehensible, and is justly prohibited by federal and municipal sanitary legislation.

The **objections against chemical preservatives of any food** may be summed up as follows:

1. All chemicals used for preservation are more or less toxic, and their ingestion injurious to health, especially if habitually used.

2. By the use of chemical artificial preservatives inferior meats and products, and meats already partly decomposed,

may be so disguised as to be sold as fresh and unspoiled products.

Heat preservation of meat is the only effective and absolutely reliable method of preservation, because it kills and destroys all entozoa and pathogenic germs, and thus renders the product sterile and absolutely safe.

For domestic use the sterilization of meat is accomplished by roasting, baking, or boiling it for from fifteen minutes to an hour. **For commercial use the process of meat preservation** must be twofold: (1) Destroying all germs by heat, and (2) enclosing the product in hermetically closed sterile vessels, in which further infection is prevented, and thus the food product preserved for indefinite periods. This process of meat preservation consists in "canning," and is accomplished by the following details: (1) Selection of appropriate meat; (2) cutting it into appropriate pieces; (3) parboiling, or exposing the meat in hot water under the boiling point for ten to twenty minutes in order to shrink it and lessen its bulk; (4) the parboiled meat is placed in cans or tins filled with salted soup or liquid and the cover soldered, except a small aperture for the escape of air; (5) the cans are then placed in boilers or steamers and subjected to high heat for an hour or two; (6) the openings left in the cover of the can are closed and the cans again subjected to a steam bath for an hour or more, according to character of product.

Sanitary Supervision, Prevention of Adulteration of Meat, etc.—The strict sanitary supervision of all the various processes through which meat passes, from the initial to the final product, is absolutely necessary in order to render the food supply free from dangerous contaminations and infection from the very many sources to which it is subjected. The prevention of adulteration by substitution, palming off inferior products for superior ones, and by adulteration with foreign ingredients, as well as by artificial preservation by means of chemicals—all these may be accomplished only by a rigid, thorough, scientific, and prompt municipal and federal inspection by qualified and competent medical officers.

IV. POULTRY, GAME, FISH FOODS, AND OTHER FOODS.

Poultry and Game.—The flesh of all domestic fowls, such as chicken, turkey, geese, duck, and of some wild fowls is used for human food.

Vacher[1] gives the following characteristics of healthy poultry and poultry meats: "Healthy poultry are active, bright, dry in the eyes and nostrils; their feathers are glossy and elastic, and the combs and wattles are firm and of brilliant red. Age is indicated by duskiness of comb and gills, dulness, fading, and brittleness of feathers, raggedness of feet, and size of claws. Good poultry should be firm to the touch, pink or yellowish in color, fairly plump, should have a strong skin, and a fresh, not disagreeable odor. Stale poultry loses firmness, becomes bluish in color, green over the crop and abdomen; the skin readily breaks, and the bird has a disagreeable odor."

"Drawn" or **"undrawn" poultry** is sold according to whether the internal organs are removed or not. Undrawn poultry decomposes sooner on account of intestinal putrefaction.

Cold-storage undrawn poultry may be dangerous to health by its deterioration, and as there does not seem to be an economic necessity of preserving poultry for long periods, as it may be obtained at all times, the practice is reprehensible.

The practice of keeping poultry or game for a certain time until it is "ripe," or "gamey," and partly decompósed, is dangerous to health.

Forced feeding does not seem to produce any pathological conditions in the poultry, and even the "fatty liver" of forcibly confined and fed geese, in the much-priced delicacy "pâté de foi gras," does not seem to affect the gourmands injuriously.

Live poultry is subject to many and various diseases, which render the meat unfit for use, and the necessity of rigid antemortem inspection is apparent in this as well as in other meats.

Fish Foods.—A very large variety of sea and fresh water fishes are used for food. Fish are allowed to die by deprivation of the oxygen.

Fish should be used in season, should be fresh, firm, and elastic to the touch. Fresh fish may be recognized by the rigidity due to rigor mortis, the freshness and red color of the gills, the moist, clear eye, and not disagreeable odor.

Frozen fish is not palatable, and decomposes very rapidly on thawing. There are many cases of toxic and ptomain poisoning from eating stale fish.

The eating of certain shellfish, crabs, lobsters, and oysters is at times fraught with danger to health, and many cases of wholesale poisonings have been reported at different times.

Oysters are frequently purveyors of typhoid fever, as they have been the cause of the disease, when they are grown in waters near large towns, the waters of which are very much contaminated by sewage and typhoid germs. The danger of oysters is the greater in that they are very often eaten raw.

Fish are preserved by smoking, drying, salting, pickling, and also canning.

The sanitation of the establishments where fish is prepared for canning does not differ much from the rules laid down for the sanitation of the manufacture of meat products.

Other Foods.—Of the other foods that are most important to health are eggs, cereals, nuts, fruits, vegetables, condiments, and beverages. The public supply of the foods may become dangerous to health by reason of their deterioration, decomposition, adulteration, preservation with injurious chemicals, etc.

Eggs when eaten in a state of decomposition are often the cause of gastro-intestinal disturbances. Eggs are preserved by means of cold storage, also by coating their outer shells with lime or some ingredient making the shell impervious to air and the entrance of microörganisms.

Cereals and **nuts** are used in a raw state, also cooked, and for the preparation of bread and in the form of gruels, etc.

Fruit and **vegetables** which largely consist of water, and owe their chief value to the sugar, acids, and aroma, are extensively used, and are

Owing to the perishable quality of most fruits and vegetables, their use is limited to certain seasons, and much care must be taken during their transportation and handling. All fruits and vegetables undergo rapid decomposition, and the ingestion of such food may become injurious to health.

Careful inspection of fruit and vegetables is maintained by all progressive municipalities, in order to prevent the sale of partly decomposed stock.

Fruit and vegetables, being largely eaten in a raw state, may act as vehicles of transmission of disease germs through contact with infected persons. The preliminary washing, the prohibition of exposure to dust and dirt, and boiling, are the best preventive measures against infection.

Fruits and many vegetables are preserved by drying, by means of condiments, by boiling and canning, also by chemical preservatives, which latter is, and should be, prohibited.

Condiments are used as relishes and in the preparation of other foods. They are largely adulterated.

Oils, sugars, and various beverages are used extensively, but cannot be discussed here.

QUESTIONS.

What are the dangers to health of ingestion of meat foods?
What parasitic diseases may infect meat?
What pathogenic bacteria may infect meat?
What are toxins and ptomains and their relation to meat?
Name the various causes of unfitness of meat for food.
What are the conditions of animals rendering their meat unfit?
What are the postmortem changes affecting meat?
How are meat foods adulterated?
What are the general means of prophylaxis of meat foods?
State the sanitary requirements for care of the health of food animals.
State the essential features of the sanitation of meat-packing houses and meat-food factories.
Give essential points of antemortem meat inspection.
Give essential points of postmortem meat inspection.
What are the characteristics of good meat?
What are the methods of meat preservation?
What are the advantages of each and the objections to each?
What chemicals are used in meat preservation?
What are the objections to chemicals as means of preservation?
State the methods of meat preservation by "canning."
What are the essential points of a sanitary supervision of meat foods?
What diseases are poultry liable to suffer from?
What are the characteristics of good poultry meat?
What are the characteristics of good fish?
State the essential points of sanitary supervision of other foods.

CHAPTER VII.

MILK SUPPLY.

I. MILK SUPPLY AND PUBLIC HEALTH.

Milk is a universal food. It is the sole food of millions of infants under one year of age, the main food of children during their first years of life, and an important adjunct food in the diet of all persons of all ages and conditions.

According to the United States census there were consumed by the people of the United States (except the farming and dairy producing population) not less than 740,000,000 gallons of milk, or about 23 gallons per capita (1900).

A pure milk supply is therefore of paramount importance to public health, not only because milk is a universal food, but also because milk, being an animal secretion and a most favorable medium for bacterial growth, is very seldom pure, and is capable of causing and transmitting disease.

The effects of an impure public milk supply are noticed on the rate of infant mortality and upon the general morbidity and mortality from certain causes.

Milk and Infant Mortality.—Infant mortality is very much greater than general mortality. The greatest causes of infant mortality are the gastro-intestinal diseases. Gastro-intestinal diseases are chiefly due to impure food. Milk being the chief food of infants, infant mortality is chiefly due to impure milk.

The following statistical data as to the foregoing logical conclusions are proof of **the relation of milk to infant mortality**:[1]

1. **The Enormous Infant Mortality.**—In England (1905) the general death rate was 15.2 per 1000. The death rate of infants was 128 in rural, and 183.8 to 198.3 in cities, per 1000 births.

[1] The statistical data are taken from Bulletin No. 41, Milk and its Relation to Public Health.

In Germany, of 1000 children born alive, 235 die during the first year.

In France, the death rate of infants under one year was, during 1892 to 1897, per 1000 deaths of all ages, 145.35 (in Paris), and 184.73 in other large cities.

In the United States, out of 545,533 deaths in the registration area during 1905, there were 105,533 deaths among infants under one year.

The greatest infant mortality is in Russia (268 per 1000 births during 1892 to 1901); the lowest infant mortality is in Norway (90 per 1000).

2. **Gastro-intestinal Diseases as Causes of Infant Mortality.**—Out of the 105,553 infantile deaths in the United States during 1905, 39,399 died from diarrhea and enteritis.

In Paris and in other cities of France having a population of over 30,000, the deaths from diarrhea per 1000 infants dying from all causes, was from 212.8, in January, to 606.4 in August.

Other data show the same large proportions of infants' death due to gastro-intestinal diseases, and the increase of the rate during the hot summer months.

3. **Breast Feeding and Pure Milk Lessen Infant Mortality.**—According to Newsholme, the number of deaths from epidemic diarrhea of infants under one year of age is not much more than one-tenth among breast-fed babies as compared with artificially fed babies.

The death rate in the New York Infant Hospital in 1902 was 7.47 per cent. among breast-fed babies, while among bottle-fed babies it was 62.14 per cent.

In 1891 the death rate among New York's children under five years was 96.2 per 1000, and 136.4 during the summer months; while after the increase in the consumption of Strauss' pasteurized milk, the death rate of 1906 was but 55 per 1000, and but 62.7 during the summer months.

Milk and Disease.—The intimate relation of milk with certain diseases has been claimed by many sanitarians and proved in many instances.

Tuberculosis from Milk.—Despite the fact that bovine tuberculosis is not identical with human tuberculosis, and that primary intestinal tuberculosis is very rare, Koch's assertion that cow's milk does not cause human tuberculosis is vigorously combated by most investigators. The comparatively greater frequency of tuberculosis among children has been cited as a strong argument, among others, for the causative relation between milk and tuberculosis. The tubercle bacilli, so often found in milk (according to Hess, 16 per cent. of New York City milk is tuberculous), are certainly not without effect on the persons consuming such milk, especially when such persons are weak, young, and suffer from some gastro-intestinal diseases denuding the mucous surface of the intestinal tract.

The transmission of the germs of other diseases, such as **typhoid fever, scarlet fever, diphtheria,** and **measles in milk,** have been proved beyond doubt in the many epidemics of those diseases which were shown directly due to infected milk.

The pathogenic germs of typhoid fever have often been found in milk, where they rapidly develop and multiply. This germ may also be found and transmitted through various milk products, like ice-cream, cheese, buttermilk, etc.

A large number of violent epidemics of typhoid fever have been traced to infected milk.

The most classical example of a milk-infected typhoid epidemic occurred at Stamford, Conn., during 1895, when 97 per cent. of all the 386 cases were traced to milk supplied by one dealer. The source of infection of the milk of that dealer was proved to be an infected well. Numerous reports of scarlet-fever epidemics due to milk infection have been reported from time to time, a typical case being that of Norwalk, Conn., in 1897. Besides the foregoing diseases, it has also been found that **foot-and-mouth-disease, "milk sickness," Malta fever, cholera,** etc., are traceable to milk.

Besides causing certain infectious diseases by the germs of pathogenic bacteria which it may contain, milk is also capable of causing certain **gastro-intestinal disturbances,** which often result fatally, especially in infants. These are due either to

various acid and other bacilli which may develop in the milk during and between the time of milking and consumption, or the diseases may be due to certain toxins produced in deteriorated milk, and the action of which is not always evident.

Even slightly soured milk may cause diarrhea in young infants, while milk which is impure has been known to cause violent colic and intestinal inflammation.

Sources of Contamination of Milk.—The sources of bacterial contamination of milk are very many, and may be classified as follows: (1) The milk animal; (2) the dairy farm; (3) the water; (4) individuals handling the milk; and (5) milk utensils.

The Milk Animal.—The quality of the milk depends greatly on the condition of health of the milk animal.

The better the health, the housing, the feeding, and the care of the animal the purer will be its secretion—milk.

The diseases of cows which may render their milk unfit for food are many, the most important being anthrax, tuberculosis, foot-and-mouth-disease, malignant edema, cattle plague, actinomycosis, trembles, septic diseases, and local diseases of the udder and nearby organs.

The lack of cleanliness of any cow, especially of the udder, teats, tail, and under parts of the body, are important factors in the cleanliness of the milk derived from that animal.

The Dairy Farm, etc.—In its peregrinations between the producer and consumer milk goes through many places, in each of which there are many chances and sources of contamination.

The farm place, the stable, the milk house, the dairy, the creamery, the car, the bottling establishment, the wagon, the grocery store, are all places where the milk may be infected from one or another source. In all and each of these places there are persons, utensils, etc., upon which germs of typhoid and scarlet fever, diphtheria, and other infectious diseases may lurk, and which may find lodgement in the milk, and thus be carried to the consumers.

Individual Milk Handlers.—A large number of different individuals handle the milk from the time it is derived from the cow to the time it is consumed.

The farmers, the milkers, the drivers, the creamery workers, the bottlers, the milk dealers, and grocery men are some of the principal infection agents from whom the milk may derive some of the pathogenic germs with which it is often contaminated.

Milk Utensils.—Another factor in the source of milk contamination are the various milk utensils—the milk pail, the strainer, the can, the bottles, dippers, etc.—all of which may be dirty and infected by the persons handling them, and other means.

Water.—Finally, a very important source of contamination is found in the water supply of farms and dairies, of the water with which the teats and udders, the cans, pails, dippers, etc., are washed, and of the water which is sometimes intentionally, and at times unintentionally, allowed to gain access to the milk.

II. THE CHEMISTRY AND PHYSIOLOGY OF MILK.

Composition.—Milk is an animal secretion, and consists of water, in which are dissolved and suspended various solids, the relative amounts of which depend on many various factors.

The **average composition of cow's milk** is 87 per cent. water and 13 per cent. of solids.

The solids consist of: milk fat, 3.6 per cent.; casein, 3.3 per cent.; albumin, 0.7 per cent.; milk sugar, 4.7 per cent.; mineral matter, 0.7 per cent. Milk also contains oxygen, nitrogen, carbon dioxide, a certain number of enzymes and ferments, and numerous bacteria.

Milk fat is formed of the glycerides of a number of fatty acids, oleic acid forming about 50 per cent. of the whole. The fat is in the form of globules, more or less minute, distributed through the milk, and has a tendency, owing to its specific gravity being lighter than that of the rest of the fluids, to rise to the top, forming what is called "cream."

Cream is not all fat, nor is it all the fat contained in the milk, but simply the upper layer of the milk containing a comparatively larger percentage of milk fat.

The **sugar of milk** is lactose. It is less sweet than grape sugar, and is converted in the presence of lactic ferments into lactic acid.

The **proteid matter of milk** is largely casein, and but a small percentage of albumin.

The **minerals of milk** are salts of sodium, calcium, potassium, chlorides, iron, etc.

The composition of milk is not always the same, and there are a number of physiological and pathological conditions which alter the composition of milk to a greater or lesser degree.

Foremilk is the first four or five streams of milk derived during the milking; it is very poor in fat and very rich in bacteria.

Strippings is the last part of milking; it is very rich in fats.

Skim milk is milk from which part or all the cream has been removed.

Cream is the top layer of the milk separated by gravity or by aid of centrifuge.

Colostrum is milk derived from cows about a week before and five days after parturition.

Condensed or evaporated milk is milk from which a considerable portion of water has been evaporated.

Buttermilk is the product that remains after butter is removed from milk and cream in the process of churning.

Whey is the product remaining after the removal of fat and casein from milk in the process of cheese-making.

Koumyss is the product made by the alcoholic fermentation of mare's or cow's milk.

Butter is the product made by gathering in any manner the fat of fresh or ripened milk or cream into a mass, which also contains a small portion of the other constituents of milk, and contains not less than 82.5 per cent. of milk fat.

Cheese is the sound, solid, and ripened product made from milk or cream by coagulating the casein thereof with rennet or lactic acid, with or without the addition of ripening ferments and seasoning, and contains not less than 50 per cent. of milk fat.

Physical Characteristics of Milk.—Normal milk has a white or slightly yellowish color, is opaque, of sweetish taste, and pleasant odor.

Colostrum differs from normal milk in its containing more of albumins than caseins, in its consequent coagulability by heat, in the sugar being a dextrose, and in its containing blood and colostrum corpuscles.

The **reaction of milk** is amphoteric, *i. e.*, it is acid to litmus and alkaline to turmeric. After lactic acid fermentation takes place the reaction becomes acid, while during later nitrogenous decomposition the reaction may be distinctly alkaline.

The **specific gravity of milk** depends on the amount of the solids and their character. Milk fat is of lighter specific gravity than water, while the other constituents are heavier. The specific gravity at 60° F. is 1029 to 1032. The specific gravity is lowered by higher temperature, decrease of solids, increase of water, increase of fats, and is higher on increase of total solids, decrease of water and fat, and lower temperature.

Bacteria in Milk.—Milk even when freshly drawn contains a large number of microörganisms. While most of the microörganisms are due to **external sources,** it has never been possible to obtain a milk which is entirely free from them. It is probable that some bacteria may be found within the udder, as there were found several growths of bacteria even in milk drawn from the udder through a sterile cannula.

Theg reater part if not all of the bacteria in milk are derived from outside sources, and the greater the number of persons handling the greater the number of changes from one place to another, and from one vessel to another, and the less cleanliness about cows, stables, etc., the greater the number of bacteria in the milk.

The **number of microörganisms in the milk** may vary from 500 in a cubic centimeter in a milk drawn under the most rigid and special aseptic precautions to 22,000,000 in a cubic centimeter found in some market milk.

Ordinary commercial milk contains a variable number of

bacteria. The minimum for standard "certified" milk is 10,000 per cubic centimeter, for "inspected" milk 100,000. Ordinary market milk may contain from 1,000,000 to 10,000,000 of bacteria per cubic centimeter, and, according to Rosenau, the general milk supply of Washington, D. C., averaged, in the summer of 1907, 11,270,000 per cubic centimeter, and 22,134,000 in 1906.

The microörganisms found **in milk** embrace almost all varieties. *Streptococci* and *staphylococci* abound in great numbers; the *bacillus coli communis* is a frequent guest; *pathogenic germs* may be often present, although most of the microörganisms are the *non-pathogenic types.*

Some of the bacteria present in milk are capable of producing changes in its composition. Of these, the most important are lactic-acid organisms, to which the lactic fermentation of the milk is due; also the organisms producing the changes and fermentations in the casein, fat, as well as other components of the milk.

Some of the bacteria may produce certain toxins which may cause gastro-intestinal inflammations in children or adults, while the pathogenic bacteria may cause the specific diseases of which they are the morbific agents.

Changes in the Milk.—As soon as milk is drawn from the cow certain physical, chemical, and biological changes begin to take place within the fluid.

The **physical changes** are those produced by the separation of the milk into an upper layer of cream and a lower of skim milk. Later on, further separation of the solid part of milk from the fluid, by coagulation, etc., may take place.

The **chemicobiological changes** are due to ferments, enzymes, and bacteria.

Chemical Changes.—The *lactose* of the milk is split up into lactic acid, alcohols, etc. This causes the increasing acidity of the milk, which acidity at first stops and inhibits other fermentations and changes, but later may be overcome by butyric, proteid, and other fermentation, to which changes in the constitution, odor, reaction, etc., are due.

When first drawn, milk is said to contain certain "germicidal

properties," which exert a restraining influence on the multiplication of bacteria in sour milk. This germicidal property is destroyed by heating.

To bacterial activity are also due the changes in the color or taste in the milk. Thus at times a red or blue milk, or a ropy, slimy milk, or an intensely bitter milk, is produced.

Milk Adulteration.—Milk is adulterated by the addition of water, by dilution, by subtraction of cream or skimming, by both watering and skimming, by the addition of thickeners, coloring, etc., and by the addition of artificial preservatives; it is also regarded as adulterated when it is below a certain chemical or bacteriological standard which is prescribed by a state or municipality.

III. PROPHYLAXIS IN MILK SUPPLY.

The Sanitary Production of Clean Milk.—The best means to prevent the spread of disease and the ill effects from impure milk is a thorough system of sanitary production of milk and its sanitary supervision from the time it leaves the milked animal to the time it reaches the consumer.

The production of clean milk embraces the proper regulation of the following **major sanitary details in the production and marketing:**

The water supply and drainage of the farm.

The surroundings, barnyard, and stabling of the cows.

The care for the health and the feeding of the cows.

Milking, milkers, and care of milk.

The regulation of dairies, bottling and milk establishments.

Water Supply and Drainage of Dairy Farms.—The close relations between drainage, water supply, and clean milk make it imperative that provision is made for the efficient and sanitary removal of all waste matters, and also for the supply of pure uncontaminated source of water supply.

Privy vaults and leeching cesspools should not be allowed at all on dairy farms, a proper disposal of sewage on such places being some form of irrigation, surface or subsurface,

or earth closets and removal of all fluid sewage to distant fields and garden.

Manure should not be allowed to accumulate in barnyards and stables, but should be collected twice daily, pressed into barrels, or removed into distant parts of the fields, upon which it may be spread, provided the drainage of such fields may not contaminate sources of water supply.

No source of water supply should be situated within several hundred yards from stables, barnyards, privy vaults, or cesspools, nor anywhere where they may receive the drainage from the same. Ponds, small surface collections of water, rivers which are contaminated by sewage and surface drainage, and shallow wells should not be relied on for the supply of water for the dairy farm; and cisterns, springs, and deep wells, when used, should be protected from contamination with sewage and properly constructed, covered, and cared for.

Surroundings, Barnyard, and Stables.—All places where milk animals are kept and all their surroundings should be kept free from manure, dirt, refuse, and stagnant pools of water, nor should they be situated near marshy or water-logged ground.

Barnyards should be located on elevated ground, with sloping sides to facilitate drainage, and should be used exclusively for the cows, no other domestic animals being allowed within, nor should they have accumulations of dirt and refuse or stagnant pools of water.

Stables should be specially constructed for the purpose. One-story buildings of brick or concrete are best; no open second-story haylofts should be allowed, nor any cellars or manure pits under the stables. When stables are constructed several stories high, each floor should be separated with dust-tight floors.

Floors are best to be constructed of bricks laid in cement mortar, or of concrete with cement top, or of tiles—never of dirt or wood.

Walls and ceilings should be hard plastered on their inner surfaces and whitewashed, or painted with light-colored oil paint.

The floors should be properly graded to one point, where they should be drained into a sewer, if present, or into a distant cesspool, properly cleansed, emptied at certain intervals, and cleaned and disinfected.

Single stalls should be of at least the following dimensions: 3½ feet wide, 7 feet long, and 9 feet high, and should be provided with iron stanchions for securing the cows. The mangers at the head of the stalls should best be constructed of concrete, without nooks and corners, being thus easily washed and cleaned. At the foot of all stalls there should be provided a gutter, or valley drain, of iron or concrete, for the receiving of urine, etc., and such gutter should be covered with a removable perforated cover, such gutters to be graded and drained into the sewer or cesspool.

There should be at least 600 cubic feet of space for each cow in the stable, and proper provisions should be made for the entrance of fresh air through lowered openings and windows.

There should be a window or skylight for every twenty feet or fraction thereof of the length of the stable, and there should be at least four square feet of glass surface for each cow.

It is best to have in the stable separate compartments, unconnected with the general stable, for cows that are sick or parturient.

No water closets, privies, etc., should be located within the stables, nor should pigs or other domestic animals be allowed within the barnyard or stable premises.

Stable doors and windows should be provided with screens to prevent flies and mosquitoes from annoying the cows.

The walls, floors, ceilings, and all parts of stables should be cleaned daily with water. The stables should be periodically emptied, so as to be thoroughly aired, and disinfected with solutions of lime, bromine, or formaldehyde.

Care, Health, and Feeding of Cows.—No milk should be taken from cows that are suffering from general diseases, from cows that are greatly emaciated, that are overdriven, overexcited, or frightened, nor from cows that suffer from some local septic disease of the teats or udder.

Special care must be taken to detect cows that are suffering from tuberculosis, and to exclude such cows from the herd. Cows should be tested with tuberculin by competent veterinarians at stated intervals, and all cows which react to the test be excluded and destroyed.

Daily examination of the cows for any abnormalities and signs of incipient disease should be a routine procedure of the caretaker of the animals.

Cows must not be abused, overdriven, or allowed to be pestered by flies or domestic animals. They must be protected from too glaring sunshine, from rain and storm, must be kept in the pasture, in the fresh air, and exercised daily.

Proper provision for a supply of pure water must be made, and cows should be fed on fresh hay, grass, corn, and whole grains, but no ill-smelling fermented vegetables, worm-eaten fruit, strong-smelling vegetables, weeds, brewery swills, marsh grass, sour ensilage, nor any foul food should be given to cows. Salt should be accessible at all times.

Cows should be cleaned, brushed, and groomed daily, and the under surface of body, the abdomen, and flanks should be washed with warm water immediately before milking and wiped with a damp cloth. The hair on the tail and around the udder should be clipped short.

The air of stables at milking time should be free from dust or offensive odors, and no sweeping or disturbing the manure should be done immediately before or during milking.

Milkers, Milking, and the Care of Milk.—Milkers shall be free from general and local diseases, shall pare their nails, scrub their hands, and wash them before milking, and shall don special clothes, caps, overalls, which shall be white and clean, and not be used for any other purpose or at any other time.

The milking shall be done with dry hands, evenly, quietly, gently, cleanly, and thoroughly, and about the same time and by the same persons every day.

Discard the first few streams of milk—the foremilk—which is very poor in fat and contains very many germs; also reject any milk which looks abnormal in color or consistency.

If part of the milk is accidentally contaminated with dirt or flies, etc., reject that part of the milk, and do not mix it with the rest of the milk.

Narrow-mouthed, partly covered pails are preferred for milking, and sterilized gauze or cotton should be put over the metal strainers.

Pails and other utensils should be rinsed in warm water, scrubbed with an alkaline solution and water, scalded with hot water, and boiled or sterilized in a steam sterilizer.

No loud talking, sneezing, coughing, tobacco spitting, or general expectoration should be allowed during milking.

The straining and cooling of the milk after milking must not be done in the stable. Separate independent milk houses, specially constructed for the purpose, separate from any other building or the living house, should be provided for the handling and keeping of the milk from the time it is taken from the stable to the time of its removal to market, such milk houses to be free from any domestic animals, clean, without dust and dirt, the inner surfaces of walls and ceilings clean and whitewashed, the floor hard and cleansible, and provided with plenty of natural light and windows for ventilation.

The straining of the milk must be done carefully and aseptically, and any machinery used for aëration or cooling be kept clean and in sanitary condition.

When the milk is cooled by immersion in tubs of running water, care must be taken that no water gain access to the milk.

The temperature of milk must be rapidly reduced to 45° F.

Regulation of Dairies, Bottling Establishments, and Stores.—Dairies and creameries must be well lighted and ventilated, the inner surfaces of walls be clean, whitewashed, or painted with light-colored oil paint, so that they may be washed with hot water. The floors are best made of concrete, tiles or stone laid in cement mortar, and the establishments used for no other purpose except the handling of milk and its products.

No bottling should be done anywhere except in establishments specially fitted for the purpose.

Bottling machines should be made entirely of metal, with

no rubber about them, and should be sterilized in a closed steam sterilizer before every bottling.

Milk cans should be of metal, or glass, with smooth joints, without seams, nooks, or corners; bottles should be of the variety called "common sense," and be capped with sterilized paraffined paper disks.

Cans, bottles, and all other milk utensils should be cleaned by first being thoroughly rinsed in warm water, then washed and scrubbed with a stiff brush and soap, or other alkaline solution, and hot water, and after that, being sterilized by boiling or in steam sterilizers, after which they must be dried and kept inverted in free air and clean places.

Stores in which milk is sold and handled should be clean, their walls and ceilings whitewashed, and floors well scrubbed and clean. The milk can should be kept at a distance from foul and strong-smelling vegetables, and foods should be kept at the temperature of 45° F., and the can covered at all times, and the milk should be stirred before each sale.

No sleeping should be allowed on the premises, nor should there be any communicating doors or openings between the store proper and living rooms, and no children or domestic animals be allowed in the store or near the milk vessels.

The refrigerator where milk and its products are kept should be clean and free from foul odors, and the waste from said refrigerator, when not otherwise properly connected, should be made to discharge into a properly trapped, sewer-connected, water-supplied open sink in cellar or in store.

During transportation milk should be kept refrigerated, and the temperature not over 50° F., and the cans should be full, well covered, and the milk protected from too much, agitation and churning.

Cans and bottles should be labelled with the name of the wholesale dealers, as well as with the name of the dairy from which the milk is derived, with date of milking, and if pasteurized, with the date of such procedure.

Milk Preservation.—The rapid changes produced in the milk immediately after its being derived from the animal, changes due to chemical, fermentative, and bacterial processes

in the milk, make it incumbent that milk should be consumed as soon after its production as possible.

This is impossible in the larger cities, which get their milk supply from distant parts—sometimes several hundred miles distant—and therefore the milk coming to the inhabitants of such cities is at least twenty-four or forty-eight hours old.

Unless some means of preservation are used, milk could not be kept for so long a period without deterioration.

The simplest and cheapest method of preservation is by means of low temperature.

Cold does not kill bacteria, nor does it destroy the infective quality of pathogenic bacteria; it is, however, one of the best means of inhibiting the action of bacteria, retarding their development, preventing the milk from rapidly becoming soured and from undergoing fermentative changes.

Cold does not change the digestibility nor the character of the milk and its constituents, and a clean milk, not containing too many bacteria, will keep sweet and wholesome for a day or more at a temperature of under 50° F.

Boiling the milk for a short time kills a number of bacteria, but does not destroy all the spore-bearing organisms, and a complete sterilization, *i. e.*, destruction of all spore-bearing bacteria, toxins, and ferments, may be accomplished only by subjecting the milk to a temperature of 248° F. for at least two hours.

Spore-bearing bacteria are not often found contaminating the milk, and boiling for fifteen to thirty minutes is ordinarily a safe procedure, and may furnish a sterile milk.

Boiling and sterilization of milk, however, produce certain changes in the milk which make it less digestible and undesirable, especially as an infant food.

The changes produced are caramelization of the lactose, partial coagulation of the serum albumins, destruction of all ferments, expulsion of carbon dioxide and other gases, certain changes in the mineral constituents, altering of appearance and taste, and rendering it less digestible.

Pasteurization of Milk.—By pasteurization of milk is understood a process of heating the milk at a temperature and for

a time sufficient to destroy the most common pathogenic germs, without at the same time destroying the ordinary milk ferments, nor altering its taste, appearance, and digestibility.

According to Rosenau, the best temperature and length of time for efficient pasteurization is heating the milk for twenty minutes at a temperature of 60° C. (140° F.).

This temperature and length of time do not destroy the ferments and do not alter the milk, but absolutely destroy all known pathogenic germs, such as those of tuberculosis, typhoid, cholera, dysentery, diphtheria, tetanus, etc., excepting only the spore-bearing organisms. Pasteurized milk must be rapidly cooled immediately after heating.

Advantages of Pasteurization of Milk.—(1) That most if not all of the common bacteria and their toxins are killed. (2) That the ordinary ferments and germicidal properties of the milk are not destroyed. (3) That the process may be accomplished on a large scale, and furnish a commercially safe milk. (4) That the taste, appearance, odor, and cream-separation quality of the milk are not altered. (5) That pasteurized milk, if kept cold, furnishes a clean, healthy milk, safe for infant food and other uses.

Disadvantages of the Pasteurization of Milk.—The following are some of the objections which are urged by the opponents of pasteurization upon a large and commercial basis:

1. That the spore-bearing bacteria and bacterial toxins are not destroyed, and the milk is therefore not wholly safe.

2. That pasteurization stops lactic-acid fermentation, and thus destroys the only "nature's danger signal," and the first symptom by which aged milk is known.

3. That unless pasteurized milk is rapidly cooled and kept under 50° F., certain fermentative changes which are ordinarily stopped by lactic-acid fermentation increase in activity, owing to the destruction of lactic-acid bacilli by the pasteurization.

4. That pasteurization, by preserving unclean milk for some time, may induce the producers to furnish dirty milk, discourage rigid cleanliness, and promote carelessness on

the part of the producer who relies entirely on the pasteurization to preserve the milk.

5. That pasteurization furnishes a "purified" milk instead of a "pure" milk.

However, similar objections may be urged against filtration of drinking water, and, much as it is desirable to obtain a perfectly clean milk within a few hours after milking, this is as yet impossible for large cities, and pasteurization on a large scale, provided it is done under sanitary supervision, is still the best method of preservation. It is to be insisted upon, however, in commercial pasteurization, that the milk bottles, etc., should be plainly labelled with degree, time of heating, and time of drawing of the milk.

The objections to the chemical artificial preservation of milk by formaldehyde, borax, and boracic acid are the same as those enumerated in the section on artificial preservation of meat and other foods. It is entirely prohibited.

Sanitary Supervision of Milk.—A complete system of sanitary supervision of milk must embrace the following measures:

1. State inspection and tests of cattle dairy.
2. Inspection of drainage and water supply of dairy farms.
3. Periodical inspection of dairy construction, equipment, etc.
4. State or municipal licensing of all establishments and persons producing, manufacturing, transporting, or selling milk.
5. Periodical inspection of farms, creameries, factories, stores.
6. Formulation of official standards of milk and milk products.
7. Formulation of bacterial standards for milk.
8. Collection of samples and chemical and bacteriological examination.
9. Labelling of all milk sold, with the time of production, place, owner, roads and means of transportation, and names of wholesale dealer, etc., so as to fix responsibility.
10. Commercial pasteurization on a large scale under sanitary supervision of municipal authorities.

The foregoing measures are necessary if a pure milk supply is to be guaranteed for the inhabitants of large cities and for the prevention of the ill effects of impure milk upon public health.

Foodstuff Standards.—A standard of food is a measure of food quality established by law.

The "standards of foods expressed in form of definitions are so fixed that a departure from the maximum or minimum prescribed is evidence that such article is of inferior quality."

The following are the U. S. standards for milk and its products:

	Solids not fat.	Milk fat.	Total milk solids.
Milk	8.5%	3.25%	11.75%
Skim milk	. . .	. .	9.25
Condensed milk	. . .	7.0	28.00
Cream	. .	18.0	
Butter	. . .	82.5	
Cheese	. .	50.0	
Ice cream	.	14.0	
Fruit ice cream	. .	12.0	

IV. MILK INSPECTION AND TESTING.

The **methods of examining and testing milk** for the different impurities it may contain, and detecting the adulterations to which it is often subjected are physical, chemical, and bacteriological. By the **physical examination** is determined the appearance, color, odor, and specific gravity of the milk, together with the variations from the normal. By the **chemical examination** we may determine the exact amount of solids in the milk, also the exact percentage of each solid in the fluid. A **bacteriological examination** will determine the number of bacteria in the milk and the presence or absence of pathogenic bacteria in the same.

The **precautions in the examination of milk** to be taken are: (1) That the milk must be thoroughly mixed; (2) that it should not be partly frozen; (3) that the milk to be tested should not be partly churned, or partly separated of its cream; and also (4) that it should not be partly or wholly coagulated.

In order to make proper tests, we must take **fair samples of the milk** from a given quantity of the marketed milk, and precautions must be observed in the manner of taking samples, so as to get a fair and just sample of the whole quantity of milk to be tested, instead of but a small part of the fluid.

A thorough mixing of the milk is necessary in order to give it uniformity, and in order that the sample of milk taken for testing should fairly represent the whole milk to be tested instead of but a part.

Partly frozen milk will not give a good test, because the frozen part represents the watery part of the milk, so that the rest of the milk will show a richer fluid and a higher percentage of solids.

Milk which has been partly churned and has butter granules floating in it, or milk from which the cream has wholly or partly been separated, will naturally not give the normal percentage of fat in the fluid, and the sample of the milk taken may not be a fair sample of the whole fluid.

A milk which has been partly or wholly coagulated will not give a fair sample for testing because of the separation of the whey and solids.

Milk which is partly frozen must be thawed, so that the whole fluid becomes uniform; milk which has been partly churned and contains butter granules floating in it must be heated, so that these granules melt; milk which has been partly or wholly coagulated must, if a sample from it must be taken, treated with alkalies sufficient to dissolve the coagulum; while a milk which has been partly separated of its cream must be thoroughly mixed and made uniform before the sample is taken.

In mixing milk care must be taken not to stir too violently, so as not to churn the milk or to mix it with air; the best means of mixing milk and getting a uniform mixture is by pouring from one vessel to another.

The **physical examination of milk** is of very great importance, and may give valuable information to the inspector. The color of the milk, its opacity, its resistance to the immer-

sion of a lactometer, its adherence to the instrument, the visibility of the instrument through the glass test-tube, are all valuable indications in the hands of an experienced inspector. A milk which is bluish in color, which allows the lactometer to sink with little resistance, which runs down the instrument in thin bluish streaks, which hardly adheres to the instrument, and which is so little opaque that the instrument is readily seen through the test-tube, is a milk which is poor in solids and which is probably either skimmed or watered, or both—skimmed *and* watered.

Milk is often tested by the cream gauge, pioscope, and lactoscope. The **cream guage** is simply a graduated glass test-tube in which the milk to be tested is allowed to stand for twenty-four hours, after which time the amount of the cream, as indicated in the yellowish layer on top, is read off. A good milk usually shows about 14 per cent. of cream. In order to facilitate the better separation of the cream, the milk is mixed with an equal amount of water and the resulting layer of cream is multiplied by two to show the actual amount of cream in the milk. The milk in the gauge is also to be put in a cold place, which favors the separation of the cream. This is a crude test.

The **pioscope** (Heeren) is a small ingenious instrument to test the quality of milk by its opacity and color. The instrument consists of a small rubber disk with a small depression in its centre, and of a glass plate painted in segments of varying shades of colors representing the color of cream, rich milk, normal milk, poor milk, skimmed milk, watered milk, etc. The inspector takes a drop of the milk to be tested and places it in the central depression of the hard rubber disk, covers it with the glass plate, and compares the opacity and color of the milk with the various segments in the circle. In the hands of an experienced inspector this is a fairly reliable test.

The **lactoscope** (Feser) also tests the milk by its opacity. The instrument consists of a graduated glass cylinder, in the centre of which, at the bottom, is fixed a small white rod with several black lines on its face; 4 c.c. of the milk to be tested

are put into the cylinder, making the black lines on the rod invisible through the opacity of the milk. The test consists in carefully measuring the amount of water needed to be put into the cylinder to render the fluid transparent, so as to make the black lines upon the rod visible. It is obvious that the poorer the milk is in quality the *less* water will it be necessary to have in the cylinder in order to make the mixture transparent; and, on the contrary, the richer the milk, the *more* water will it be necessary to add. The instrument is graduated and shows the amount of estimated fat in the milk according to the number of cubic centimeters of water added.

Specific Gravity.—The testing of milk by its specific gravity is the most frequently employed test, and is very valuable in conjunction with the general physical examination of the milk.

The specific gravity of milk depends on the solids in the fluid. Of these solids, sugar and the proteids are heavier than water, while the fat is lighter. The specific gravity of average normal milk is 1029, and may vary in normal milk between 1029 to 1032. The specific gravity is calculated at 60° F.

Milk which has been skimmed, *i. e.*, from which a part or the whole of the cream has been separated, will show an increased specific gravity, because the absence of the fatty portion will make it denser and heavier. A milk which is diluted with water will show a decreased specific gravity because it is made thereby much less dense and thinner.

The testing of milk with the **Quevenne lactometer** is based upon the relative specific gravity of the milk. This lactometer is graduated from 15 to 40, the scale reading as in ordinary hygrometers and showing the corresponding degree of specific gravity. A good milk will read (at 60° F.) upon this lactometer 32, showing a specific gravity of 1032, an average standard milk will read 29, a watered milk will read less than 29, according to the amount of water (0 being water), while a skimmed milk will read more than 32, up to 40, according to the amount of cream subtracted.

The **lactometer of the Health Department of New York,** extensively used in many places in the United States, is a larger instrument and is graduated differently from the Quevenne lactometer. According to this instrument it is assumed that 1029 is the lowest permissible specific gravity of standard milk, and these 29 degrees, divided into 100 subdivisions, from the top figure, 0, showing the reading of water at 60° F., to 100, which will correspond to 29 on the Quevenne instrument, or 1029 specific gravity on the ordinary hygrometer. The lactometer is graduated from 0 to 120. According to the Board of Health lactometer a poor normal milk will read 100, a good rich milk will read between 100 and 110, a skimmed milk will read between 110 and 120, while a watered milk will read under 100, the amount of water added being indicated in the reading, *i. e.*, 10 per cent. of water being added if the lactometer read 90°, 25 per cent. at 75°, etc. This instrument is more convenient for use, as the stem is longer and the degrees may be read more readily, and also the exact amount of probable addition of water may be more readily calculated.

As the lactometric readings are calculated at 60° F., corrections must be made for any difference in the temperature of the milk above or below 60° F. When the difference in the temperature is very great, it is best to reduce or increase its temperature to within 10° of 60°. The correction for the temperature is then 0.1° of the Quevenne lactometer for every 1° of temperature, and 0.3° of the Board of Health lactometer for every 1° of temperature above or below 60°; *added* to the reading when the temperature of the milk is above 60° F., and *subtracted* from the reading when the temperature of the milk is below 60° F. The usual rough correction for the Board of Health lactometer is 4 degrees on the lactometer for every 10 degrees on the thermometer, added or subtracted according as it is above or below 60° F.

As the specific gravity of milk is increased by skimming and decreased by watering, some milk dealers first subtract a certain amount of cream, thus increasing the specific gravity and lactometer reading, and then add sufficient water to again decrease the specific gravity and lactometer reading to about

normal, so as to deceive the inspector and give an adulterated milk showing a normal reading on the instruments. The only recourse of the inspector is then to compare the physical appearance of the sample of milk with normal milk, when there will appear the difference in the color, opacity, and density of the fluid.

The **chemical tests of milk** consist in the examination for the exact percentage of solids, and for the testing for the amounts and percentage of each component solid. The usual tests being those of weighing and evaporation for the exact amount of solids, and the Babcock test for the determination of amount of fat in the milk. For the complete chemical and bacteriological tests of milk the student is referred to special works on these subjects.

QUESTIONS.

What are the relations of the milk supply to infant mortality, tuberculosis, and typhoid fever?
What are various sources of milk contamination?
State the composition of milk and characteristics of each component.
Define the following terms: foremilk, strippings, skim milk, cream, colostrum, condensed milk, butter, buttermilk, cheese, whey, koumiss.
Describe color, appearance, reaction, and specific gravity of milk.
What are the variations in the color, appearance, and taste?
Describe the number and role of bacteria in milk.
Describe the changes in milk in the first twenty-four hours after milking.
How is milk adulterated?
Describe the methods for securing pure milk.
Give rules governing the care of milk cows.
Give rules governing the barnyard stable.
Give rules governing drainage and water supply of dairy farms.
Give rules governing milk houses and milking, utensils and milker.
Give U. S. standards for milk, cream, skim milk, butter, and cheese.
What are the means of milk preservation?
State advantages and disadvantages of each.
Give advantages of pasteurization and objections to it.
State chemicals used for milk preservation and objections to them.
What are the precautions to be taken in mixing milk?
How are samples of milk to be taken for testing?
Why is partly frozen, or partly separated, or coagulated milk not to be taken as samples for testing?
What is determined by the physical and by the chemical examination?
What is the cream gauge, and how is it used?
What is the lactoscope and how is it used?
What is the pioscope, and how is it used?
What is the specific gravity of milk, and to what is it due?
What increases and decreases the specific gravity of milk?
Describe the Quevenne lactometer and method of its use.
Describe the New York Board of Health lactometer and its use.
Give corrections for temperature variations on both lactometers.

CHAPTER VIII.

DISPOSAL OF WASTE MATTER.

I. WASTE MATTER AND PUBLIC HEALTH.

Kinds of Waste Matter.—In every human settlement with large numbers of persons present, there are bound to be accumulations of various waste matter, which if not immediately and effectively disposed of may become a menace to the health of the community.

The waste matter is of various kinds, as follows:

1. Waste matter due to natural elements—rain or snow.
2. Street refuse.
3. House refuse.
4. Industrial waste.
5. Dead bodies—human and animal.
6. Sewage proper.

Amount and Quality of Waste Matter.—These vary with each kind.

Rain and Snow.—The quantity of rain and snow falling upon a given city may be calculated by the multiplication of the amount or depth of the annual rainfall, or snowfall, by all the street and roof surfaces in the city. Rain and snow are mixed with a large amount of dirt gathered from the dust in the air and on the roof and street surfaces; the exact amount of such impurities is difficult to calculate. There may be considerable organic matter and bacteria in the rain and snow water. (*Durand-Clay* has found in Paris storm water 127,000 germs to the cubic centimeter.)

Street refuse consists of ashes, cinders, dust, paper, straw, fibrous matter, animal and vegetable refuse, coal, bones, offal, rags, bottles, metals, crockery, manure and excreta, dried and wet sputum and expectoration, and innumerable other organic and inorganic matter.

The quantity of street refuse differs according to many circumstances and factors. In New York City it amounts to nearly 4,000,000 tons a year, or, approximately, one ton a year for every living human being.

The amount of organic matter in the street refuse is very large; according to some authorities it is from 14 to 22 per cent.

Numerous investigations have been made of the number of bacteria in street refuse. *Manfredi* found in the street refuse of Naples 6,668,000,000 of bacteria to one gram of refuse, with an average of 716,000,000 per gram. *Uffelman* found in Rostok street refuse from 2,000,000 to 40,000,000 of germs to the gram.

Among the germs found in the street refuse and proved to be pathogenic by inoculation, were the *staphylococcus pyogenes aureus, streptococcus pyogenes,* the bacillus of malignant edema, the tetanus bacillus, tubercle bacillus, etc.

House Refuse.—The quantity of house refuse is very large. House refuse consists of various organic and inorganic matter, such as sweepings, rubbish, papers, garbage from kitchen and table, remnants of food, detritus from the various activities within the house, etc.

House refuse contains much organic matter of decomposition, wet and dry sputum, expectorations, etc., and, very often, scales and discharges from scarlet fever, typhoid, measles, and other infectious diseases.

Industrial Waste.—A very large amount of waste matter comes from the various industrial processes—from laundries, slaughter houses, stables, tanning factories, and the thousands of other various industrial establishments.

A large part of industrial waste matter consists of organic matter, and may undergo decomposition and contain various germs.

Dead Bodies.—The number of dead bodies of human beings and of animals differs according to the population of the city and the rate of mortality.

The organic matter of dead bodies speedily undergoes decomposition and putrefaction, is attacked by millions of

insects and germs, and contains a large number of pathogenic germs, especially in those who die from infectious disease.

Sewage.—By sewage is meant the liquid and solid excreta from animals and human beings.

The manure and excreta from horses is a part of street refuse, although a large part of the same is contained in the refuse of stables, etc.

According to *Frankland*, an average human person voids about 40 ounces of liquid and 3 ounces of solid excreta.

According to *Zuruck*, the yearly amount of sewage for 100,000 persons will be 3650 tons of solid and 36,000 tons of liquid excreta.

The percentage of organic matter in feces varies from 21 to 25.

The number of microörganisms in sewage varies.

According to *Suckdorf*, there were found 381,000,000 of microörganisms in 1 gram of the fresh feces of a person fed on a mixed diet.

Feces and urine undergo rapid putrefactive changes on exposure to the air, and especially when mixed.

According to *Sedgwick*,[1] the average composition of fresh sewage in Lawrence, Mass., during the morning for 1897 was (parts per 100,000):

Free ammonia.	Albuminoid ammonia.			Chlorine.	Nitrogen as		Oxygen consumed.	Bacteria per cubic centimeter.
	Total.	Soluble.	Insol'ble		Nitrates	Nitrites.		
3.19	1.26	0.78	0.48	13.36	0.18	0.0182	7.59	4,726,000

Hygenic importance of waste matter depends upon the following factors:

1. The commercial value of the waste matter.
2. Their odors and effluvia.
3. Their bulk and appearance.
4. Their toxins.
5. Their infection of soil, air, and water.

[1] Principles of Sanitary Science and Public Health.

While the **commercial worth of the waste matter** is seemingly an economic matter and not a sanitary one, the fact of the economic value of most waste matter bears a direct relation to its sanitary utilization and disposal. The expense of disposal may be much lessened if the organic and other valuable matters could be extracted and utilized.

While the **odors and effluvia of most waste matter**, and even of decomposing sewage matter, have not been found capable of directly causing disease, there is no doubt that their unpleasantness and the disgust produced by them may be injurious to health, by preventing the enjoying of fresh air and producing nausea, anorexia, etc.

The same may be said about the disagreeable appearance of most waste matter.

All decomposing matter evolves **gases** and contains **toxins** which may affect health. Sulphur gases, ammonia, sulphuretted hydrogen, carbon dioxide, marsh gas and other gases which in concentrated form may become toxic are produced by putrefactive changes in organic matter. The so-called "sewer gas" is not a gas at all, but the air of sewers, which may or may not be mixed with other gases, and may or may not become detrimental to health, according to its purity. Sewer air was regarded formerly as capable of causing certain diseases. This is denied at present.

The most dangerous elements and properties of all waste matter, and especially of sewage, lies in the possibility of their carrying **infection by the pathogenic germs** which they may contain.

The elements of infection are discharged by diseased animals and by man through the skin, respiratory and alimentary canals. Hence these discharges contain all the elements of infection, and will produce the infection when ingested or brought into contact with uninfected human beings.

The sputum, the expectoration, the skin scales, the discharges from the bowels may, and often do, contain tubercle bacilli, scarlet fever, diphtheria, smallpox, measles, typhoid, cholera, and other pathogenic germs, and may thus transmit these diseases by those waste matters.

The transmission may be accomplished directly from person to person, or through the medium of clothing, or by the aid of insects, or by means of the air, soil, and water.

The dust of air may contain tubercle bacilli and other germs.

The soil does contain large numbers of pathogenic germs, but these cannot escape from the soil unless by the aid of water.

Insects often carry the germs of typhoid, tuberculosis, etc., from sewage and sputum to the food of man.

Water is very often contaminated by typhoid, cholera, and other pathogenic germs through the sewage thrown into the water or through drainage of same through soil.

Even sea water may at times become a vehicle of typhoid fever, as has been proved by sea water infected with sewage contaminating oysters and other edible fishes. Thus in 1908 in New York City, 113 cases of typhoid fever were traced to the use of raw oysters infected with contaminated sewage.

II. DISPOSAL OF WASTE MATTER.

Rainwater.—The disposal of rainwater becomes a serious problem in cities where the pavements and exposed surfaces are covered by non-absorbent materials interfering with the draining of storm water into ground; nor is the collection of large stagnant pools of water desirable from a sanitary standpoint.

Rainwater collected on roofs, street pavements, etc., is commonly disposed of by the sewerage system.

In the **combined system of sewerage** the rainwater is disposed of through the same pipes through which the sewage passes. This system necessitates pipes of larger caliber, in order to take care of the occasional large quantities of storm water, which water serves also to give the sewer pipes a thorough flushing. On the other hand, the large caliber sewer pipes of the combined system cause a very sluggish flow of sewage in them in ordinary times, with consequent adherence of sewage to the sides and a decomposition of

sewage and creation of foul gases. The utilization of the sewage is also more difficult in the combined system because of the large dilution of the sewage and the expense of separating the solid excreta from the fluid.

In the **separate system of sewerage** the rainwater is removed separately through a distinct system of pipes taking care of the rainwater only, and this water may safely be disposed of into rivers and nearby watercourses without special danger of contamination with sewage matter, as in the combined system. For smaller cities, with modern sewage-treatment plants, the separate system of drainage is much more preferable, and, although it requires a double system of pipes, etc., is cheaper in the end, and less objectionable in many respects.

Snow.—The large snowfall during certain months of the winter and the accumulation of the snow in the streets of cities may become a nuisance and detrimental to health, on account of the mixing of large amounts of organic street refuse matter with the snow and contamination with offensive refuse and possibly with products of decomposition and pathogenic germs.

The removal of snow from city streets presents many difficulties and gives great trouble to municipalities. The common method of hiring men to shovel the snow into piles, from which it is loaded into wagons and dumped into the sea, rivers, or outlying places near the city, has many objectionable features, and is very expensive and difficult to control. There are some patented devices which melt the snow in the streets and dispose of it into sewers, but such machines are as yet not very efficient.

Street Refuse.—An absolutely efficient and sanitary system of street cleaning and of disposal of street refuse has as yet not been devised, in spite of the fact that it is a problem of paramount importance to public health, and very large sums of money are spent upon street cleaning by municipalities.

The **street-cleaning problem divides itself into three parts**—(1) The collection, (2) the transportation, and (3) the final disposal.

The **collection of street refuse** is commonly done by street sweepers, using brooms, shovels, and cans. There are used also machine sweepers, which gather the dirt from the street for several feet at a time and leave it there to be collected by the street cleaners. Most of the hand as well as machine sweeping is done without preliminary thorough wetting, with a consequent raising of dust and scattering of refuse by wind, etc. The whole process is extremely crude and unsanitary. When the streets are sprinkled it is better, but the sprinkling is usually very perfunctory and not thorough enough to prevent the raising of dust. A scientific, efficient, objection-free system of collecting street refuse has not as yet been devised, or, at least, not introduced.

The efficiency of the collection also depends on the kind and character of street pavement. The time of collection of street refuse is important, and the practice in some cities, which collect and clean streets at night, when the cleaners are undisturbed, and furnishing clean streets for the beginning of the day, seems to have many advantages.

After collection, the **transportation of street refuse** in wagons, etc., demands care and the provision of well-covered wagons, so that the dirt and dust be not blown off the wagons by the wind, and also that certain offensive sweepings, manure, etc., should be prevented from giving off their effluvia in the streets.

The **final disposal of street refuse** differs in various cities. A large percentage of the inorganic and organic matter in the street refuse has an economic value and may be utilized for various purposes. Indeed, in some cities the scow trimmers and contractors pay large sums for the privilege. Dumping the accumulated refuse into the sea and watercourses does not seem to be an efficient system of disposal. The best mode would seem to be the extraction from the refuse of all of its valuable ingredients and destroying the remainder in specially designed destructors or crematories, the heat of which is at the same time utilized for some such purpose as generating electric power, etc.

The **disposal of house refuse** is essentially a part of the

general problem of disposal of refuse in cities. A large part of the house refuse may be destroyed in the house, and the other refuse may be utilized in many ways.

The **separation and collection into separate receptacles of the ashes, papers, and garbage,** which represent the three main kinds of house refuse, makes the utilization of the refuse much easier, as the papers and rubbish may be economically used for various purposes, if not for fuel; the ashes may be used for filling in swamps, etc., while the garbage and remnants of food may be utilized in the manufacture of soap, fertilizers, etc.

Trade Waste.—The disposal of the waste and refuse matter which are produced by industrial establishments is regarded by some municipalities as the duty of the owners of the industries. Industrial establishments may utilize a large part of their waste matter, and the remainder may be disposed of by properly constructed destructors. Municipalities have a right to prohibit the disposing of trade-waste into rivers and watercourses, unless such waste matter is previously chemically treated and made harmless.

The **collection, removal, and disposal of offal and dead animal bodies** is one of the functions of the municipality, and is necessary to prevent the decomposition of the offal upon the street and becoming a nuisance to public health. The prompt removal in specially constructed wagons of the dead animal bodies is done by the health authorities, and the carcasses are utilized for soap and other manufactures, or destroyed under the supervision of the same authorities.

Disposal of Dead Human Bodies.—The necessity for prompt and efficient disposal of dead human bodies is self-apparent.

The disposal of dead bodies may be accomplished by two methods—burying and cremation.

The previous **embalming** or **antiseptic treatment of the body** may be of benefit to public health by the effective destruction of any and all infective organisms within the dead body.

Cremation is an efficient method of disposal, and has many advantages, the principal one being the destruction of the

bulk of the body, the elimination of all possibility of any subsequent infection by the body, and the general sanitary features of the process. With the scarcity of burying plots in large cities, the general cremation of dead bodies is bound to become a more frequent method than it is at present.

The universal method employed hitherto, with few exceptions, is by **burying in the ground** and letting the soil and its bacteria dispose of the organic parts of the dead body. The objections against burial of dead bodies is the necessity of large plots of land near cities and the possibility of infecting the air, soil, and water near the burying plots. The question of infecting the air and the soil of burial places is not of so much importance as the undoubted danger of pollution of watercourses through the drainage of infective matter from the burial grounds and cemeteries into near-lying rivers and watercourses, which may act as sources of public water supply. The transportation of bodies of those dying from infectious diseases is also a matter of sanitary regulation.

III. DISPOSAL OF SEWAGE.

Sewage is the liquid and solid excrementa mixed with water.

Sewerage is the disposal of liquid and solid excrementa mixed with water by means of underground pipes called sewers.

Drainage means the disposal of any liquids and waters by means of drains or pipes.

Drainage is distinct from sewerage, and may have nothing to do with it, as, for instance, when a marsh or water-logged ground is drained off by means of canals, etc.

The immediate disposal of sewage from houses has already been spoken of in the chapter on housing hygiene.

The final disposal of sewage gained from dry methods of house disposal consists mostly in the utilization of the dry sewage for fertilizer, as the concentrated form of the sewage is economically very valuable.

The final disposal of sewage gained from sewers, mixed as it is with large volumes of liquids and water from rains, etc., presents at times more serious problems.

The **disposition of sewage from sewers** may be subdivided as follows:

1. Disposal into rivers, lakes, or seas.
2. Precipitation.
3. Filtration and irrigation.
4. Bacterial methods.

1. The **disposal of sewage into rivers and lakes** may be harmless to public health, provided: (1) The amount of sewage is small; (2) the volume of the water in the rivers and lakes is very large; and (3) the *rivers or lakes are not at the same time used as a source of water supply*, either by the community disposing its sewage into them or by any other community.

Small amounts of sewage are oxidized and made harmless if diluted with large volumes of water, but the danger of polluting the water supply of towns by such sewage is too great to make the practice of disposing of sewage into rivers, etc., sanitary.

The disposal of contents of sewers into seas and oceans would seem to be of no danger to public health, and has been regarded as a favorite and convenient, as well as cheap, method of sewage disposal in all towns situated upon seas and shores of oceans.

Practically, however, it has been demonstrated that this seemingly harmless method is not without serious objections and dangers to health.

The **objections to sea disposal of sewage** may be summed up as follows:

(*a*) The bottoms of inland harbors are raised by the accumulations of sewage, and the exteriors of ships, etc., are fouled.

(*b*) The shores of health resorts on the sea and the immediate surroundings of sea-bathing establishments are fouled by the floating and scattered sewage matter.

(*c*) The infection of oysters, fish, etc., with typhoid fever germs.

The fouling of the immediate neighborhood of bathing establishments is a serious danger to health, but the greatest danger to public health is, as has been proved by the investigations of Dr. Soper and the Metropolitan Sewerage Commission of New York, the possibility of infection of the oyster crop. During 1908, 113 cases of typhoid fever were traced directly to the ingestion of infected oysters, which are commonly grown in polluted sea water near towns.

These and other considerations have made the disposal of sewage into rivers, lakes, and even into seas, not desirable and injurious to public health, and other, more effective, less harmful, and more scientific methods of final disposal of the sewage from towns preferable.

Methods of Sewage Disposal.—Of the older methods, the more valuable are physical and chemical precipitation, also filtrations and intermittent irrigation. Of the more modern methods, the biological deserves the greatest attention.

2. **Precipitation.**—The solid parts of the sewage may be partly removed or separated from the liquid mass by mechanical precipitation or sedimentation, and the liquid part may then be drained off into rivers, etc., while the solid part is utilized in one way or another. The precipitation of the solid particles of sewage is accomplished either by gravity in large tanks, at the mouths of sewers, or by means of screens, revolving blades, and other devices.

Chemical means may be employed to assist or to cause precipitation; and the iron salts, copper sulphate, lime, alum, etc., have been used for the purpose of forming flocculent precipitates, which, on settling, are supposed to clarify the sewage from most of its solid and harmful parts.

Intermittent soil filtration has been defined by the Metropolitan Sewage Commission as "the concentration of sewage, at short intervals, on an area of specially chosen porous ground, as small as will absorb and cleanse it, not excluding vegetation, but making the produce of secondary importance. The intermittency of the application is a *sine qua non* even in suitably constituted soils wherever complete success is aimed at."

11

Sewage is effectively purified by passing through soil, sand, gravel, etc., and this process is not only filtration, but complete purification, as the soil acts biologically upon the organic parts of the sewage, provided the filtration is not continuous and the soil is rested for certain intervals. As, however, large filter beds are needed for the disposal of large volumes of sewage (one acre of filter bed for the sewage of 1000 to 2000 persons), this method is not always practicable in communities where land is valuable or scarce.

Electricity has been recommended as a means of destroying or disinfecting sewage matter, but so far has not proved itself of much value.

3. "**Irrigation**" has been defined by the Metropolitan Sewage Commission as "the distribution of sewage over a large surface of ordinary agricultural ground, having in view a maximum growth of vegetation, consistently with due purification, for the amount of sewage suplied." It is practically the same as filtration, done intermittently, applied to garden and vegetable land, with the purpose not only of purifying and disposing of the sewage, but of utilizing the organic parts of the sewage for fertilizing purposes as well. This method has been used with great success in Berlin and Paris and other places. The objections raised against this method are partly the same scarcity of land and, additionally, the possibility, proved in some instances, of contaminating the growing vegetables, etc., with pathogenic germs from the sewage, a danger which is specially enhanced by the fact that many of the vegetables are eaten raw.

Subsoil irrigation is the same process, but modified, in that the sewage is conducted to the irrigated land, not superficially, but by means of porous earthenware drains, placed a few inches underneath the ground.

Both surface and subsoil irrigation are valuable means of economic final disposal of sewage, and have been largely adopted abroad, but the system does not seem to find favor in the United States.

4. **Bacterial processes of sewage disposal** (**biological, bacterial, or septic methods**) consist essentially of two processes.

First, the **liquefaction, dissolution,** and **putrefaction of the sewage** due to the action of the bacteria present in it, such bacteria acting without the presence of air or oxygen, and therefore called anaërobic bacteria. This process consists in placing the sewage in covered septic tanks or containers, where the sewage, without the presence of air, undergoes a process of decomposition, fermentation, and putrefaction, which effectively breaks up all solid particles, liquefies the whole substance, and renders it favorable for the action of the next **nitrifying process.**

The next process is the exposing of the liquefied effluent from the septic tanks to the action of aërobic bacteria by running it slowly through open sand filters, a **modified process of intermittent filtration,** which nitrifies the sewage and makes the effluent of the filter beds entirely free from all harmful matters and germs.

The various septic tanks, strainers, filter beds, and other works necessary for the bacterial sewage purification are very complicated, and their erection is in the province of the sanitary engineer.

There are a number of various patented processes of septic sewage purification, but they are all based on the principles briefly stated above.

The **great advantages of bacterial sewage disposal** is the complete removal of sewage of every town without respect to its size, location on rivers, seas, etc., and the effective destruction of all harmful products in the sewage. Indeed, it has been proved that the final effluent from the filter beds is capable of supporting the life of fish, and even the drinking of it has been known not to be followed by injurious results.

The process is also comparatively economical, and disposes of any and all harms of the usual disposal of sewage into rivers, lakes, seas, and of any other means of disposal.

The septic process of bacterial sewage disposal is extensively employed in England, and is rapidly being introduced in the United States.

QUESTIONS.

Name the various waste matters in towns and villages.
State the quantities of each of the waste matters.
Describe the relations of the various waste matters to public health.
What are the methods of disposal of rainwater?
What are the methods of disposal of snow?
What are the methods of disposal of street refuse?
What are the methods of disposal of house refuse?
What are the methods of disposal of dead animal bodies?
What are the methods of disposal of human dead bodies?
What are the various methods of final disposal of sewage?
What are the objections to ocean, sea, and river disposal?
Describe the methods of disposal of sewage by intermittent filtration.
Describe the disposal of sewage by surface and subsoil irrigation.
What are the biological methods of sewage disposal?
What are their advantages?

CHAPTER IX.

PUBLIC NUISANCES.

Definition.—A public nuisance in the general sense is the use of one's property, or an action on the part of a member of the community, which may interfere with the liberty, comfort, or health of other members of the community. An example of such a nuisance may be had in the encumbering by a merchant of the sidewalk before his store, or the obstruction of the street by builders with accumulation of building material. Such nuisances do not affect the health, but interfere with the liberty and comfort of the members of the community, and therefore come under the head of **preventable nuisances.**

A **public nuisance** or a **public health nuisance** is limited to such acts, etc., as are detrimental to health or dangerous to life.

It is not always possible to prove the exact danger to life and injury to health of certain nuisances, and it has been regarded that even such acts which are merely a discomfort to other members of the community and only remotely detrimental to health may also be included under the category of nuisances. Thus among the public nuisances which are regarded as coming under the proper jurisdiction of health authorities is everything that produces noise, smoke, dust, dirt, smell, gases, and fumes.

Any person, establishment, trade, industry, etc., which produces one or more of the nuisances named is thereby violating the public health laws to which he is amenable, and is also liable in case he does not abate the nuisance after due warning and order by proper authorities.

NOISE AS A PUBLIC NUISANCE.

As a public nuisance we may regard the excessive noises which characterize modern city life.

A large part of the city noises are unavoidable and a necessary product of the intense urban activity and life, but there are also many noises which are entircly unnecessary and preventable, and hence a public nuisance.

While it is not possible exactly to prove the direct danger to life or the injury to health of excessive city noises, it is undoubtedly a fact that these noises are not without harmful effects, if not to healthy adults, at least to the delicate in health, to invalids, sick, convalescents, women, and children. In such persons excessive noises interfere with sleep and rest, produce irritability, insomnia, nervous disturbances, neurasthenia, and general debility.

We may also presume that excessive street noises may directly endanger life and limb by deafening pedestrians and preventing them from hearing danger signals and thereby from avoiding vehicles, automobiles, etc.

The **causes of most street city noises** may be classified as follows:

1. Street pavements.
2. Street traffic.
3. Street transportation.
4. Trades and industries.
5. Street vendors, etc.
6. Noisy persons.

Street pavement noises are prolific and due to the material and character of the pavement. Especially noisy are stone and granite block pavements, and these become noisier with age, wear and tear of the stones and blocks, producing holes and crevices which make much noise on contact with vehicles, etc. Wood and asphalt pavements are much less noisy.

The **street traffic noises** are those caused by the rumbling of wagons, the hoofs of horses, the wheels of the wagons, the tramping of the feet of pedestrians, and many other

similar causes. The greatest part of street noises is undoubtedly due to the means of transportation, to the horse, steam, and electric cars and tramways, the rails, the crossings, and the terrific noises made by the heavily loaded cars upon the iron rails and crossings, especially when those rails are loose, the car wheels worn and flat, and the street crossed and recrossed by a network of loose rails and switches

The **noises of various industries**, such as blacksmiths, lumber mills, machine shops, boiler works, printing presses, etc., need no description.

Other unnecessary additions to the pandemonium of city noises are furnished by the multitudinous street pedlers, hawkers, criers, fiddlers, organ-grinders, orchestras, etc.

Finally, the Babel of city noises is much augumented by the population itself and its extraordinary vociferations during work, pleasure, or play, and especially the young generation, who consider their greatest pleasure to be in the most noise they produce.

Among the **avoidable noises** we may regard some of the following: Whistling of factories, ringing of church bells, noises caused by defects in street pavements, by defects of cars and means of transportation, by loose rails and flat wheels, by transportation of rails and iron on wagons, by the street noises of pedlers and hawkers and street musicians, or by some of the industrial processes.

The **prevention of city noises** may be accomplished by many of the following measures:

1. Education of the public in the harm of unnecessary noises.
2. Municipal legislation prohibiting excessive noises.
3. Prohibition of street music, cries of pedlers, wagon bells, etc.
4. Substitution of stone pavements by asphalt and wood.
5. Compelling all wagons, etc., to have rubber tires and good springs.
6. Removing of all noisy industries from residential districts.

7. Supervision of street rails and cars and other means of transition.

8. Removal of children, etc., from streets by provision of playgrounds, parks, etc.

SMOKE AS A PUBLIC NUISANCE.

Sources.—The black smoke which is belched forth by so many establishments in large cities is a source of public nuisance, not without effect upon public health.

The **composition of the smoke** as it leaves the chimneys varies and depends on the kind and character of the fuel and on the methods of combustion.

Smoke is the unconsumed part of the fuel, and consists of suspended carbon particles with an admixture of various gases, such as hydrogen, carbonic acid, sulphur, etc.

Smoke is a nuisance because it contaminates the air by the addition of impurities, darkens the streets, causes fogs, discolors all house and street surfaces, smirches laundry and clothes, interferes with ventilation of houses by the disinclination of householders to open the windows, and causes a cheerless, sombre city appearance.

The **smoke nuisance may be prevented** by compulsory use of hard instead of soft coal, by proper methods of combustion, by installation of smoke consumers, and similar mechanical improvements.

DUST AS A PUBLIC NUISANCE.

Sources.—Large amounts of dust are produced by households, by processes of street cleaning, and by industrial establishments.

Prevention.—The dust produced by households, such as beating of carpets, rugs, etc., may be prevented by proper sanitary regulation and prohibitions to beat carpets in streets, etc., also by improved methods of housing sanitation, by vacuum cleaners, etc.

The provision of water-sprinkling machines, or the use of oil and other dust-laying fluids, the use of improved cleaning machinery, covered carts, etc., may eliminate some of the worst features of present street cleaning.

All industries creating excessive dust should be removed from the city precincts, and, besides, should be compelled to provide themselves with means of controlling the dust, utilizing and collecting the same. Many dusty processes of carpet-beating, sand-blasting, and other dust-producing establishments have been eliminated by more modern methods of industry, vacuum methods of cleaning, etc.

WASTE MATTERS AS PUBLIC NUISANCES.

Sources.—Mention has been made already of the nuisance caused by various industries in which a large quantity of waste is produced and this waste then disposed of into the public water supply system or any water courses which may serve as such.

The number of such industries is large, and such a disposal of their waste matter may be regarded as a public health nuisance. Sugar refineries; breweries; paper, starch, gas, alkali, color, chemical, and other works; tanneries; laundries; oil and other factories are among the many which thus become a nuisance by the improper disposal of their waste matters.

Prevention.—The abatement of the nuisance may be accomplished by strict legislation and compulsory installation of waste-consuming and waste-reducing plants in each of the mentioned industries.

GASES AND FUMES AS PUBLIC NUISANCES.

Sources.—A prolific cause of public nuisance in communities are the many industries in which various deleterious gases and fumes are evolved.

The gases and fumes which are evolved by various trades, and which may be regarded as public nuisances because of their harmful effects on their surroundings and on human beings, are sulphur, sulphuric acid, sulphuretted hydrogen, carbon monoxide, coal gas, water gas, chlorine, bromine, ammonia, and others.

Among the offensive trades evolving some of the foregoing gases are the color, dye, and chemical works in general, lead, arsenic, soda, potash, alkali, petroleum, coal-tar and an infinite number of other similar manufactures; also the manufacture of illuminating gas, the various metal works, etc.

Such trades are commonly designated as "offensive," and do become a "public nuisance" when their gases. fumes, and odors interfere with the health and comfort of the community in which they are situated.

The **harm of offensive trades** cannot always be fully determined, but may be summed up in the following: Offensive and foul odors vitiating the air of the neighborhood near the works, destruction of vegetation in the neighborhood, and the direct effect of the injurious gases.

Prevention.—The prevention of the above works from becoming a public nuisance is within the province of the sanitary engineer, who is to devise for each industry a specially fitted form of prophylaxis, destruction and elimination of its injurious gases, etc.

The following measures may be regarded as a *résumé* of the **sanitary control of offensive trades** likely to become public nuisances:

1. Municipal control, supervision, and license.

2. Restriction of territory within which any offensive trades may be located, and removal of specially offensive trades from inhabitable portions of the town.

3. Dilution of the offensive gases and fumes by large volumes of air, by the construction of very tall chimneys conducting the deleterious gases high into the external air.

4. Condensation of deleterious gases, etc., by water coolers, or by passing the gases through water-filled condensers, or wet coke scrubbers, etc.

5. Absorption of the gases in fire-pits, where they may be destroyed by the action of fire or by passage through some neutralizing substance, which is, of course, different for each gas.

6. Constant inspection of such offensive trades by competent, techincally educated inspectors, who shall note the exact causes of the nuisance and suggest proper remedies.

ODORS, EFFLUVIA, ETC., AS PUBLIC NUISANCES.

Sources.—The greatest number of the so-called offensive trades become a public nuisance through the odors and offensive effluvia produced by them.

It is not always possible to determine the **harmful effects of offensive odors on health.** Indeed, it is doubtful if the offensive odor by itself is capable of causing sickness or injury to the health of a robust normal person. Nevertheless, it is regarded by almost all civilized communities that the production of offensive odors constitutes a public nuisance, the abatement of which devolves upon the sanitary authorities.

While it is true that it is difficult to prove the harmful effects of offensive odors upon robust adult persons, it is less difficult to prove such deleterious effects upon invalids, upon convalescents, upon those suffering from various diseases, and upon all persons in whom interference with free enjoyment of breathing, with sleeping, and with rest may produce harmful effects. It is certainly true that such an interference does take place in the presence of offensive odors, and such an interference with breathing, sleep, and rest may become not only injurious, but fatal in some cases.

Moreover, most industries which produce offensive odors do so by the production of organic waste matter, which, by its putrefaction, evolves foul odors, and the organic matter by itself may become a source of public nuisance aside of its odors.

The **classes of offensive trades** which may become a public nuisance because of their odors and organic waste matter may be stated in four divisions:

1. The keeping of live animals.
2. The killing of animals.
3. The sale of animal matter.
4. The manufacture of animal products.

1. **The Keeping of Animals.**—The nuisance caused by keeping live animals in stables, etc., in cities may be due to the specific odors emanating from the animals, to the odors of urine, excreta, and other waste matters, to the noises created by them, to the flies and parasites attracted by them, and finally to the possible germs likely to be transmitted by them.

All sanitary codes and municipal sanitary regulations contain detailed rules intended to control and abate the nuisance caused by the keeping of live animals.

The essence of most of the **sanitary legislation of the keeping of live animals** to abate its nuisances may be summed up in the following measures:

(*a*) State veterinary supervision of domestic animals.

(*b*) Prohibition of keeping certain animals within city districts.

(*c*) Restriction of places to certain districts, etc.

(*d*) Sanitary supervision of construction of stables, etc.

(*e*) Rules about removal of manure and sanitation of stables.

In New York, for instance, certain animals, such as pigs, goats, etc., are not allowed to be kept within the city limits, and when kept in outlying districts must be licensed. Nor are such animals allowed to be kept in tenement houses, nor the building of stables on tenement house lots, and the keeping of chickens, pigeons, etc., require permit from the Health Department. In Boston, stables are prohibited within 200 feet from a church. In Chicago it is necessary for the erection of a stable to get the permission of the owners of the property within 600 feet from the proposed stable.

The storage and keeping of animal matter, such as manure,

offal, refuse, bones, garbage, may also become a public nuisance by the odors, the putrefaction, and the decomposition, etc., caused by them, and hence sanitary regulations include the keeping of animal matters among the offensive trades.

All sanitary authorities demand that the removal of all manure and animal matter be very prompt, thorough, and periodical, and that it should be done at certain hours, during which the process of removal is not likely to become a nuisance.

The immediate destruction of all animal matter, prompt removal, and cleaning and disinfection of premises are the most approved measures to abate the nuisance.

2. **The Killing of Animals.**—The killing of animals for food purposes is one of the oldest industries in the world, and when done in special establishments within city limits may become a public nuisance by reason of the odors from the killed animals and by reason of several other features of every such establishment, such as noise, presence of animal matter, blood, decomposition, and the flies and parasites which such decomposition may attract.

The **principal nuisance of slaughter houses** is due to the large quantities of organic matter which, if not immediately removed, becomes decomposed and emits foul odors, and, moreover, may contaminate fresh animal foods.

The common **prophylactic measures** are about the same as those for keeping live animals: Restriction of slaughter houses to special districts, construction of municipal abattoirs, the construction of abattoirs with all inside surfaces made of non-absorbent material, the utilization of all blood and other by-products, the provision for the use of large quantities of water, and a complete sanitary supervision of all the features of such places, so as to make the industry odorless and harmless.

Municipal provisions about slaughter houses were inaugurated in the United States as early as in 1692, in Boston, and at present they are a feature of the sanitary code of every municipality. The construction of municipal abattoirs

would eliminate the nuisance created by private slaughter houses, as such abattoirs would be superior in their construction and be maintained in a better sanitary condition than those carried on by private interests.

3. **The Sale of Animal Products and Food.**—The establishments where various animal matter, food, etc., are sold may also become a public nuisance by reason of the odors created by such animal food, etc., also by reason of the possible decomposition of the organic matter, the flies and parasites which they attract, and the possible source of infection of the food and transmission to those who use it as food.

Among the **offensive food trades,** or rather trades which may become offensive, may be included the following: butcher stores, fish markets, fruit and vegetable stalls, public markets, grocery stores, restaurants, etc.

The **sources of nuisance** from most of these industries consist mostly in the exposure of animal and easily decomposing matter in the open at temperatures which favor decomposition and also permit the depositing of dust and street dirt upon the edible stuffs. They also consist in the exposure to putrefaction of remnants of food which allows the gathering of flies, insects, animals, etc., and the emanation of foul and offensive odors.

Regulation.—The means of controlling places where food and animal matter are exposed for sale consist in the following measures:

(*a*) Restriction of sale of fish, meat, and such products to centrally located public markets.

(*b*) The sanitary control of private establishments.

(*c*) The proper construction of such markets and shops with abundant ventilation and light, with solid, impervious, and non-absorbent walls, ceilings, and floors properly graded and drained, made of solid non-pervious and washable material, and with means of profusely flushing the premises with water and of keeping them at a temperature low enough to inhibit the development of bacteria and decomposition.

(*d*) Sanitary supervision and inspection of public and private establishments.

5. **Manufacture and Utilization of Animal Substances.**—Finally there is a group of industries which are based on the utilization of animal substances for various purposes and the manufacture from them of certain products, such industries coming under the classification of offensive trades because of the nuisance created during some processes of their work.

Such **offensive trades include** lard refining, fat rendering, blood and bone boiling, glue making, gut cleaning, the manufacture of soap, glycerin, etc., the preparation and tanning of skins and hides, boiling of oil, making of varnishes, etc.

The specific nuisance created in each of the above-named industries varies according to such circumstances, as the substances used, the products manufactured, the processes employed, and a number of other factors.

The **cardinal source of nuisance** lies in the odors and effluvia created in those establishments, an odor which usually penetrates far from the place of manufacture, and may become offensive to the inhabitants of the neighborhood.

Besides the odor, there are also in each of the enumerated trades some other offensive elements which also may render those establishments a public nuisance.

The **principles of prophylaxis** are the same in these as well as in other offensive trades with special measures indicated in each special establishment.

The most important prophylactic measure is the prohibition of carrying on these and any other offensive trades within the residential districts, and concentration of them in special places far removed from living habitation. This applies especially to such trades as hide tanning, glue making, soap manufacture, etc.

The next important prophylactic measure is the licensing of such establishments by municipal sanitary departments, in order that a complete supervision may be had of their construction and maintenance.

The proper construction of any factory where substances likely to become offensive are manufactured must be under the supervision of sanitary engineers. The buildings

must be made of hard, solid, non-absorbent material, with smooth, impervious inside surfaces, and with a special provision for natural and artificial light, ventilation, water supply, and drainage.

A great many of the offensive substances and processes in many of the above industries are not absolutely necessary, and may advantageously be substituted by less offensive methods, etc.

The use of tight vessels for the holding of all animal matter, the removal of all accumulated remnants and unused parts, the absolute cleanliness in all processes, and the copious use of water are other prophylactic measures.

Another most important prophylactic measure is the destruction of all odors by proper mechanical devices, such as their destruction by fire, by special condensers, etc., devices which may greatly abate the odors and the consequent public nuisance of such establishments.

The prevention of the disposal of the various waste matters, sludge, etc., from any of the above industries is a necessary prophylactic measure against the pollution of watercourses and streams.

QUESTIONS.

Give the definition of public nuisance.

Name the common public nuisances.

State the causes of city noises, their effects and prevention.

Give the causes, effects, and means of prevention of smoke.

Give the causes, effects, and means of prevention of dust in cities.

Give the causes, effects, and prevention of gases and fumes.

Name trades consisting in keeping live animals, the nuisance produced by the same, and rules governing such trades.

Name trades consisting in killing of animals, the nuisances produced by the same, and rules governing such trades.

Name the trades consisting in the sale of animal matter and nuisances produced by the same, also rules governing same.

Name trades consisting in the manufacturing of animal products, the nuisances produced, and rules governing such trades.

CHAPTER X.

THE PREVENTION OF INFECTIOUS DISEASES.

I. DEFINITIONS, CAUSES, AGENTS, METHODS, AND MODES OF INFECTION.

UPON examining the recorded **causes of death** we find but a very small percentage of deaths due to old age: 2 per cent. in the registration area of the United States during 1907, and but 1.4 per cent. in the city of New York for the first half of the year 1909.

During 1907 there were in the same area 7.6 per cent. of the deaths due to violence, so that over 90 per cent. of all deaths were due to disease.

Disease is defined as an antithesis of **health,** and as "a condition of the body marked by inharmonious action of one or more of the various organs or tissues, owing to abnormal conditions or to structural change."

Diseases are classified variously according to various factors, etiological or symptomatic, but, according to *Sedgwick,* they may be classed into two principal groups—constitutional and environmental.

Constitutional diseases are such as are due to intrinsic, organic, and structural defects in the body mechanism, such as diseases of circulation, digestion, metabolism, etc.

Environmental diseases are due to extrinsic factors, external interference, and to the invasion of the body by morbific agents.

Relation of Hygiene and Disease.—The prevention of all disease, constitutional as well as environmental, is the aim and function of general hygiene.

The prevention of constitutional diseases is the aim and function of personal hygiene.

The prevention of environmental diseases is within the function of public hygiene, because the etiological environmental factors are those usually acting in large groups and upon large masses of people, and also because the prevention of such diseases is possible with the coöperation of large bodies and communities.

The most **important environmental diseases** are those which are termed variously infectious, communicable, contagious, parasitic, zymotic, zymotoxic, germ, specific, etc., but which we shall include under the one term, *infectious diseases.*

Infectious diseases are such as are due to the entrance into the body of certain microörganisms of animal or vegetable origin. These microörganisms live, develop, reproduce, increase, and produce certain toxic products, which all cause certain groups of symptoms and pathological changes, which constitute the specific infectious disease, the chief characteristic of which is that it may be transmitted from one person to another person, and carried from one place to another.

This transmission, infection, or communication of one disease from one individual to another may be direct, or indirect, by contact or through the medium of certain objects, in one way, or in another, or in several ways combined.

Infectious diseases are also characterized by having certain stages, such as exposure, infection, invasion, incubation, acme, decline, etc.

The **stage of exposure** is the time during which the person is exposed to the presence of morbific agents.

The **period of infection** is the period of actual entrance of the morbific agents into the organism or system.

The **stage of incubation** is the period of the actual development of the morbific agents within the organism, or the period of the active struggle for existence between the infecting agent and the defensive forces of the body.

The **period of invasion** is the period during which the infecting morbific agents, having won their battle, the definite symptoms of disease (the **prodromal stage**), begin to manifest themselves

The **stages, acme, decline,** and **convalescence,** are characterized by the height, decline of disease, and the recovery.

The **degree of infection** depends on the number of the morbific agents, their virulence, the mode of entrance, and the vital resistance of the body.

The **incubation period** depends on the specific character of the invading morbific agents, and varies with different diseases.

Decline of the disease is either sudden—by crisis—or gradual—by lysis. Convalescence may also be delayed by "recurrence" or "relapse."

The disease may also be of **acute, subacute,** or **chronic, severe** or **mild, remittent** or **intermittent.**

Infectious diseases are termed **endemic diseases** when they appear continuously in one locality, **epidemic** when they effect a large number of persons at one time, and **pandemic** when they cover a vast area of land or several countries.

The three most **important features of infection** and **infectious disease** which must be studied for a clearer comprehension of the etiology of these diseases, are the following:

1. The morbific agents.
2. The portals of entry.
3. Modes, vehicles, and agents of transmission.

1. **Morbific Agents.**—The belief that certain diseases are caused by some living agents outside of the body is old and has been held by many ancient observers, but the proof has become possible after the perfection of the microscope and with the extensive research into the microorganic world which this instrument has made possible.

To *Pasteur,* of France, and to *Koch,* of Germany, we owe the establishment upon a scientific basis of the new **Science of Bacteriology,** to the researches in which we owe the definite proof that certain diseases are directly caused and are due to specific microörganisms, which invade and infect the human body and, by their activity and products, cause the pathological changes and train of symptoms which we call infectious diseases.

The microörganisms which act as morbific agents of disease are of animal or vegetable origin, mostly of the latter.

The **animal parasites** belong to the protozoa, insects, and worms.

The **vegetable microörganisms** are grouped under the general name of **bacteria**, which signify minute unicellular plants, and which are subdivided into a number of groups and types; one important subdivision being according to their external form; thus, the **cocci** are so named because of their spherical form, the **bacilli** have a rod-like elongated form, while the **spirilli** have a spiral form.

While millions of these vegetable microörganisms are entirely innocuous, there are among them certain species which, entering under favorable conditions into favorable soil in the human organisms, become pathogenic and are to be looked upon as the morbific agents of disease.

Among the more **important pathogenic cocci** are the following: *staphylococcus pyogenes aureus*, *streptococcus pyogenes*, *pneumococcus*, and the *gonococcus*.

The following are some of the **pathogenic bacilli**: *bacillus anthracis*, *bacillus œdematis maligni*, *bacillus tetani*, *bacillus typhosus*, *bacillus tuberculosis*, *bacillus mallei*, *bacillus lepra*, *bacillus diphtheriæ*, *bacillus influenzæ*, *bacillus coli communis*.

Among the **spirilla** the following are noted: *vibrio cholera asiatica*, *spirillum of relapsing fever*, *spirochæta pallida* (*treponema pallidum*).

Bacterial Diseases.—Some of the diseases the morbific agents of which have already been demonstrated are the following: septicemia and pyemia, pneumonia, gonorrhea, anthrax, malignant edema, tetanus, typhoid fever, tuberculosis, bubonic plague, diphtheria, influenza, cholera, relapsing fever, yellow fever, malaria, syphilis, etc.

Some of the diseases which are infectious, but the specific agents of which have not yet been absolutely demonstrated, are the following: scarlet fever, measles, smallpox, rabies, pertussis, etc.

The **pathogenic action of the morbific agents** upon the body may be due partly to mechanical, partly biological, and partly chemical action.

The very presence of the morbific agents may mechanically interfere with the physiological action of certain organs, causing stasis, hemorrhage, etc., or the increased activity of the morbific agents may cause local inflammation of tissues, infiltrations, and abscesses, or the whole body may be infected by metastatic foci by means of blood or lymph, thus carrying infection to remote parts.

A most important, if not the greatest, harm is done not by morbific agents themselves, but by their chemical products, or **toxins** which are the results of the bacterial action upon the blood and body fluids, as well as to other bacterial products—**endotoxins, proteins,** etc.

These toxins are not as yet all known, and vary in their effects and virulence according to various factors.

2. **Portals of Entry.**—Infection of the body with microorganisms is by means of entrance of these organisms into the body through certain portals of entry, which differ with each specific bacterium, so that some bacteria may be entirely innocuous when entering a certain organ of the body while pathogenic, and virulent when entering another part or organ.

The principal ports of entry are the skin, the respiratory, the alimentary, and the genito-urinary tracts of the body.

While some microörganisms may enter the healthy and normal skin, this is very rare, and the commonest mode of entrance is through some solution of continuity, through cuts, bruises, abrasions, wounds, etc.

The **skin as port of entrance** admits certain animal parasites, like favus, scabies, tinea tonsurans; also through bites of insects in malaria, yellow fever, plague, through wounds, etc., in syphilis, septicemia, smallpox, etc.

The **respiratory tract as port of entrance** admits through the mucous membranes of the nose, eyes, ears, mouth, and throat, diphtheria, scarlatina, measles, influenza, pneumonia, etc. The throat, bronchi, trachea and larynx, and lungs

may be the port of entrance of tuberculosis, diphtheria, pneumonia, influenza, pertussis, etc.

The **alimentary canal as the port of entrance** is open to typhoid, cholera, dysentery, etc.

The **genito-urinary tract as the port of entrance** is entered by gonorrhea, syphilis, chancroid, tuberculosis, diphtheria, septicemia, etc.

The different parts and tissues of the body react variously to microörganisms, while the various microörganisms have each a predilection for certain parts of the body, in some of which they thrive, while in others they succumb.

3. **Modes, Vehicles, and Agents of Transmission of Infectious Organisms.**—The pathogenic bacteria are not found free in nature, but they live in the body, the blood, the secretions and excretions, the discharges of the body, the skin and the exteriors of persons which they infect. Hence the principal agent of infection, as well as vehicle of transmission, is man himself and animals, and their discharges.

The **morbific agents are found** in the various parts and discharges of the body. Thus, certain bacteria may be found on the skin, in the secretions of the eye, ear, nose, and throat, the sputum, the expectoration, the perspiration of the skin, the urine, the solid excreta, the secretions from wounds and abscesses, etc. All the above-named secretions and excretions may contain virulent morbific agents which may be transmitted from one individul to another.

The **transmission of bacteria** may be direct or indirect, by contact, or by intermediary agents and vehicles.

Anything and anybody that may take up part of the secretions and excretions from an infected person and carry them to a non-infected person may serve as vehicle and agent of infection. Persons, animals, insects, food, milk, water, air, soil, and fomites may be then regarded as vehicles of infection.

The most frequent, and demonstrated, **mode of infection** is by direct contact of disease with the healthy, of the persons surrounding the infected one, such as physicians, nurses, etc.

Insects and animals may be the *sources*, the *vehicles*, and the *intermediate*

Animal sources of infections serve in glanders, anthrax, and other infectious animal diseases, in favus, scabies, etc., or through bites, as in rabies, plague, etc.

Animal vehicles of infection may serve in almost all infectious diseases, the morbific elements of which they may carry from diseased to healthy upon their bodies, or by means of the parasites upon them, such as fleas, bugs, etc.

Insect sources of infection carry infective material upon their bodies, legs, and wings, and depositing the same infective materials upon the bodies of healthy persons, on their mucous membranes, on wounds, in the food, milk, water, etc.

It has been clearly demonstrated that insects—flies, fleas, lice, bugs, roaches, etc.—may and do transmit infective material from cholera, typhoid, tuberculous, and other patients, and are capable of carrying infection to healthy persons, either indirectly to foodstuffs, or directly by means of their bites.

That some insects, notably the mosquito, may become the intermediary host of several infectious diseases has been demonstrated in the case of malaria, of yellow fever, and of elephantiasis.

In these diseases the infective parasite is sucked up from the blood of a human being by the mosquito, and within the body of the insect the infective agent undergoes further development, after which it may cause the disease when inoculated by the bite of the mosquito into a healthy person.

The spreading of **infection by food** has also been demonstrated and is an accepted fact.

Meat, milk, and other articles of food may become contaminated with infective material containing morbific agents, and such food and food products may upon ingestion by healthy persons cause certain infectious diseases. This is the case especially with those diseases the morbific agent of which has its port of entry in the digestive tract.

The germs of typhoid, of cholera, of dysentery, and probably tuberculosis are those which, if carried into the alimentary canal by various articles of food, may cause those diseases.

That milk is frequently contaminated with various morbific agents has already been described in a previous chapter, and the etiological relation of infected milk to disease mentioned.

Infection may also be carried by fruit, vegetables, bread, candy, and other food articles which are used without cooking, and which may carry infective material from the diseased to the healthy persons.

The infection of persons by infected oysters has already been alluded to in another chapter.

The **soil as a source** and **vehicle of infection** is claimed in plague, cholera, and other diseases, but its direct connection with diseases, except through the means of infected water, has not been directly demonstrated, except in hookworm disease.

Air as a vehicle of infection may serve through the medium of dust floating in the air, or through the droplets which are exhaled and expired by tuberculous patients.

The **relation of water to disease** has been treated in a former chapter.

Infection by Fomites.—By fomites are understood various articles and substances in use by man, which may carry infectious material and thus serve as vehicles of infection. Money, cloths, rags, bedding, underwear, books, mail, and the thousand and one other articles of use by diseased persons may be in use or handled by sick persons, may contain discharges from patients, and may carry these from them to healthy individuals.

The importance of fomites has been greatly overestimated, owing to the misunderstanding of the exact nature of morbific agents and their activity, and it is at present claimed that fomites have nothing to do in the case of some diseases, while their importance in others has been also overrated.

II. PROPHYLAXIS OF INFECTIOUS DISEASE; IMMUNITY, NATURAL AND ARTIFICIAL.

Three **conditions for successful infection** are absolutely needed: (1) Exposure and infection, or entrance into the body of a certain number of virulent morbific agents;

(2) favorable conditions for the development of infection; (3) individual susceptibility to infection.

Leaving the first two conditions for future discussion, we shall here discuss the last condition for infection and its value in the prevention of infectious diseases.

Immunity.—Not all persons are equally susceptible to the action of morbific agents and their products.

The normal body, animal as well as human, possesses a certain **natural immunity,** or resistance, to the action of bacteria and their toxins. This vital resistance has been defined by *Sedgwick* as "that condition of the normal body, plant, or animal in which it is able to cope more or less successfully with unfavorable influences acting upon it from without, *i. e.*, from the environment."

Vital resistance against infectious diseases varies with each individual, in various places and with various times and under various conditions. It may be at times so low that the individual falls an easy prey to the first exposure to infection, or the resistance may be so complete against a certain infectious disease that no matter how great the number and how virulent the morbific agents, nor how favorable the conditions, the person remains unscathed, or "immune."

Immunity then is a state of relative or complete resistance of the constitution against specific disease.

Between extreme susceptibility and complete immunity there are many degrees of partial immunity, so that these terms "susceptibility" and "immunity" are relative rather than absolute. The immunity may differ according to time, to season, to place, to country, to race, to species, to family, to age, to individual health, etc.

To cite but a very few examples: White rats are completely immune against diphtheria, rabbits and guinea-pigs extremely susceptible. The white rat is immune against anthrax, the house rat is susceptible. Among races, negroes show great immunity to yellow fever and malaria, Japanese and Chinese to scarlet fever.

Besides natural immunity, there is also an **acquired immunity**; this is notably in persons who have recovered from

certain infectious diseases. Familiar examples are small-pox, scarlet fever, yellow fever, also measles, typhoid, etc. Not all infectious diseases seem to give immunity to those recovering from them; thus persons recovering from influenza, pneumonia, tuberculosis seem not only to become immune, but, indeed, are more susceptible than before. The immunity when gained may be complete for a whole life, or may last only for a more or less short time.

The degree of vital resistance and immunity vary, as already indicated, with many factors, and in individuals with the nutrition, metabolism, fatigue, conditions of health, etc.; and one or more of these conditions either increase or decrease the natural resistance, which is therefore spoken of as **normal** or **physiological vital resistance**, or **increased physiological resistance**, as differentiated from natural and from acquired immunity.

Causes of Immunity.—As to the causes of vital resistance and immunity there are a number of theories and hypotheses; the most important ones may be summed up as follows:

The body possesses certain **defensive substances against bacteria** and their products. These defensive substances are in the blood and in the body fluids. The defensive substances in the blood and body fluids have the power either to destroy the bacteria themselves, or to counteract and neutralize the effects of the bacterial products.

The two main substances which act in a defensive capacity are the white blood corpuscles, or **phagocytes**, which "eat up," envelop, and destroy the bacteria, and the **alexins**, or compound defensive substances in the blood plasma and body fluids.

The **alexins** are subdivided into several substances, each of which seems to have a special defensive capacity, some of these substances are known as "the complement," others as "intermediary bodies," "opsonins," "agglutinins," anti-toxins," etc.

The following is a schematic presentation of the subject by *Flexner* (*Popular Science Monthly*, June, 1909):

RESISTANCE.

Natural. *Physiological.* *Increased physiological.*

.LEXINS { Complement ....probably increased.
Intermediary body.
Opsonin.
Agglutinin.

'hagocyte....................increase (hyperleukocytosis).

ACQUIRED IMMUNITY.

Complement—probably increased.
Intermediary body—specific ones produced.
Opsonins—specific, stabile ones produced.
Agglutinin—specific, stabile ones produced.
Antitoxin—(for endo- and exotoxins) produced.
Phagocyte—often increased, but qualitatively unchanged.

Opsonins are substances in the blood which make the acteria "more tasteful" to the phagocytes, or in other vords, more easily destroyed.

Opsonic index is the ratio of the opsonic influence of the lood serum of sick persons to the blood of healthy persons.

Antitoxin is a specific reaction product of bacterial toxins, apable of neutralizing the toxin.

Agglutinins are substances in the blood serum which are apable of agglutinizing bacteria.

Prophylaxis by Acquired Immunity and Increased Resistance. –In order to prevent infectious disease the natural physio-ogical resistance must be increased, or an acquired and rtificial immunity produced.

Increased natural physiological resistance is obtained y those methods which react upon the healthy body, by ie attention to the precepts of personal hygiene, by avoid-nce of fatigue, malnutrition, uncleanliness, intoxication nd other harmful influences, and by attention to bathing, ietabolism and all such body processes which increase

the natural health and physiological vital resistance of the body.

There are also certain therapeutic measures, such as the use of pilocarpine, nuclein, etc., which are known to increase vital resistance, although their practical use is limited.

Artificial Immunity.—Artificial immunity is divided into active and passive, according as to whether the immunity is developed within the body possessing it, or is transferred to it from other animals.

Active immunity is produced by the following conditions: (1) Recovery from disease. (2) Inoculation with virulent living bacteria. (3) Vaccination with attenuated bacteria; (4) with dead bacteria; (5) with bacterial extracts.

Passive immunity is conferred by antitoxins and serums.

Recovery from Disease.—Mention has already been made that recovery from certain infectious diseases confers a more or less permanent immunity. The immunity is equally conferred whether the disease is of a virulent type or is very mild, hence the exposure of healthy persons to a mild form of infectious disease may become beneficial by the immunity conferred by it against the more virulent types. As a matter of voluntary prophylaxis this form of immunity is not without its dangers.

Inoculation by Virulent Bacteria.—This is based upon the same principles as the immunity conferred by recovery from infectious disease, and has been used in the inoculation by variola. It has been employed also in cattle-plague by inoculating the cattle with virulent bacteria, but under unfavorable conditions to the bacteria (in cattle plague into the tough tissues of the tail).

Vaccination by Attenuated Bacteria.—The bacteria are weakened and their virulence greatly diminished by subjecting them to unfavorable conditions, and then vaccinating the body by the modified, weakened, and attenuated virus.

The modification and weakening of the bacteria may be done by means of a previous growth in a body of a resistant animal, as in the case of vaccine virus, also chicken cholera. The modification may also be accomplished by **drying**, as

in the case of *rabies* virus, or by means of **heat**, as in *anthrax*, or in Hafkin's first cholera serum; other unfavorable factors, such as electricity, light, chemicals, etc., may also be used to weaken the virulence of the bacteria.

Immunization by Dead Bacteria.—Instead of using for the vaccines living bacteria, dead bacteria are used, as in Hafkin's cholera, in Hafkin's plague, or in Koller's typhoid virus.

Immunization by Bacterial Products.—Finally, it was sought to produce artificial immunity by injecting into the body of bacterial products. This was used not so much for the purpose of immunization as for therapeutic purposes, as in the case of tuberculin (tuberculosis) and plasmin (cholera, typhoid).

Passive Immunity.—While active immunity is produced by the persons themselves by means of the reaction of their body blood and fluid with living or dead bacteria and bacterial products, passive immunity is produced in an individual not by his own body but by the body of some other animal, which has been artificially immunized, and whose blood serum is injected into the human being to be passively immunized.

Thus if dead bacteria or bacterial toxins are injected into non-immune horses until the horses become highly immunized the serum of these immunized horses possesses certain antimicrobic and antitoxic properties, which act as antibacterials and antitoxins if injected into the human body.

The **principal antitoxin serums** used are those of diphtheria and of tetanus, the latter as a prophylactic measure, while the former as a curative as well as prophylactic procedure. Antitoxins have also been made for cholera and for the plague.

Diphtheria antitoxin, which has played such an important role in the enormous reduction of the mortality from that disease, is at present prepared in a large number of laboratories, and it is very extensively used.

Preparation of Diphtheria Antitoxin.—The specific diphtheria bacilli are cultivated in peptone bouillon, where they

produce their toxins. The bacilli are then killed by means of heat and the filtered bouillon is injected into the blood of horses, which at first react to the toxins, but after repeated inoculations with stronger toxins are so immunized that they show no reaction, and their blood becomes so rich in antitoxins that when the serum is injected into small animals that were previously inoculated with diphtheria germs, these animals, instead of succumbing to the disease, as they invariably do without the antitoxic horse serum, recover from diphtheria.

III. PROPHYLAXIS OF INFECTIOUS DISEASE: SOCIAL MEASURES.

Significance.—In view of the fact that infectious diseases affect, as a rule, a large number of people at one time, and that the spread of these diseases is favored by density of population, congestion, means of transportation, commerce, and other means of communication, the prevention of infectious diseases must be based largely on social measures and public defensive means.

The **social prophylactic measures** adopted in modern communities to check, control, and stop the spread of infectious diseases may be summarized as follows:

1. Study, research, and popular education.
2. Report, notification, diagnosis, isolation, quarantine.
3. Domestic and hospital treatment, nurses, inspection.
4. Individual prophylaxis.
5. Public sanitary supervision of food, milk, and water supplies, schools, factories, commerce, transportation.

1. **Research and Education.**—Much of the headway gained in modern times against infectious diseases is due to the brilliant discoveries of the causes of disease, discoveries which were made possible by the existence of public and private institutions for study and research. Scientific study of the nature and causes of disease is absolutely necessary for the prevention of disease, for one cannot prevent diseases without knowing their true causes.

Another necessary measure for combating infectious diseases is the spread of popular knowledge among the masses, for until the scientific truths gained in the laboratory are common property of the mass of population the prevention of infectious disease will remain impracticable. Hence the spread of popular education about infectious diseases is one of the most important and effective means of combating the ravages of those diseases. This has been well proved in the case of the modern popular war against tuberculosis, which promises such brilliant results.

2. **Notification and Report.**—In order that sanitary authorities should be able to cope with infectious disease they must first know of its existence, hence the provisions in the sanitary codes, etc., for compulsory notification and report.

The duty of reporting the existence of infectious disease lies primarily upon the physician seeing and treating the case, but is also shared by other persons coming in contact with the infected patient.

The diseases to be reported are those which are known to be infectious and communicable, although not all sanitary authorities and communities have uniform laws to the effect.

The **diseases reported** according to the rules of sanitary authorities of most cities are smallpox, scarlet fever, diphtheria, cholera, measles, croup, yellow fever, malaria, typhoid, typhus, relapsing fever, pertussis, cerebrospinal meningitis, pneumonia, tuberculosis, erysipelas, septicemia, etc.

To be assured that the report of infectious diseases is correct, certain cities appoint **special diagnosticians**, who are to confirm the diagnosis of the private physicians, or to make the diagnosis, in case the suspected patient has been reported by a layman.

Infectious diseases spread rapidly in congested communities, hence the necessity of isolation of the infected persons from the healthy ones. Such isolation of infected persons should be voluntary wherever the population is educated and is progressive, but otherwise it must be compulsory, in order to prevent the spreading of the disease in crowded communities.

The isolation may be of the patient himself, of the room where he lies, or of the apartment or house in which he lives, as well as of the family surrounding him. The degree of isolation depends much on the disease and the intelligence of those who surround the patient. Where isolation is absolutely necessary but for some reasons cannot very well be obtained, as, for instance, in virulent cases of small-pox in crowded tenement houses, there may be ordered the compulsory removal of the patient to a hospital. The sanitary authorities of the community prescribe the exact form of isolation, order the needed quarantine of the room or house, place the necessary placards, and perform such other preventive acts as are deemed good for the public health.

The duration of isolation of patient, etc., depends on the disease, and may last but a few days in a case of diphtheria to a few months in a case of scarlet fever.

3. The **treatment of infectious disease** is either private or hospital. There is no doubt that for the public good and for the thorough eradication of infectious diseases, hospital treatment of all cases of infectious diseases would be preferable, as best tending to help not only the patient, but to prevent the spreading of the disease in the community; but there are still many objections against compulsory hospital treatment of all infectious diseases as a summary measure, and it must be limited but to certain few diseases and to the poorest part of population.

In order to exercise some control over the infectious diseases treated at home, sanitary authorities appoint visiting nurses and inspectors. The **medical inspectors** do not, as a rule, treat the patients, but have a general supervision over the case, take cultures, if requested by the family physician, inject antitoxin, or perform intubation, at the request of the physician treating the case, also determine the time of termination of period of isolation and quarantine.

Visiting nurses are a comparatively new institution, and have been introduced in but few communities, but are destined to play a more prominent role in the prevention of infectious diseases.

The nurses visit the sick at certain intervals, instruct the family of the patient in the methods of proper care of the sick one and of the various discharges, teach them of the ways to prevent infection spreading to other persons, and generally act in a friendly and advisory capacity, which must bring very good results, especially among the more ignorant part of the population.

4. **Individual Prophylaxis.**—The individual prophylactic measures consist in the care of the patient; of the discharges; of the proper disinfection of the food, water, and other supplies of the patient; of his room, apartment, and house; of the destruction of insects and other conveyors of infection, and of the many other measures necessary for the limiting of infection.

5. **Public Measures.**—Certain public measures are necessary for the prevention of the spread of infectious diseases. These measures consist in the control of public food, milk and water supplies, in the prevention of infections in schools, factories, by means of transportation, by commerce, maritime vessels, interment, etc.

The public prophylactic measures adopted to lessen and limit infectious diseases by means of public water, food and milk supplies, have already been discussed in some detail in the chapters upon those subjects.

The school as a source and field of spread of infectious diseases has also been spoken of, and the modern methods of prevention mentioned as consisting in a thorough system of medical school supervision. During epidemics it has been found necessary to close schools for certain periods.

No less a prominent factor in spreading infection is found in the factory and industrial establishments, and prophylactic measures are required to limit communication of disease in industries. The best method of prevention would be a proper medical supervision and control of all industrial establishments, with initial medical examination of employees, also periodical examination of all persons in employment and isolation of infected ones.

The supervision of commerce, transportation, means

of transit by railroads and steamships is also necessary in the work of the public for prevention of the spread of infectious diseases. The measures adopted for this purpose are the supervision and inspection of railroad and steamships, quarantine between cities, states, and countries in times of epidemics, the inspection and disinfection of vehicles, cars, baggage, etc.

Measures for supervision of the interment of persons dead from infectious diseases consist in the disinfection of bodies, means of transportation, and the provisions against public funerals in cases of communicable diseases.

IV. PROPHYLAXIS OF INFECTIOUS DISEASE: DESTRUCTION OF MORBIFIC AGENTS. DISINFECTION.

Difficulties of Destruction.—It is evident that the ideal means of prevention of infectious diseases would be the destruction of the morbific agents which have been found to be the cause of those diseases. The difficulties, however, which render this form of prophylaxis unattainable are (1) that the morbific agents of all infectious diseases are not as yet known; (2) that the known morbific agents are microscopic, invisible to the eye and cannot be found without special and expert knowledge; (3) that the microscopic causative agents of diseases are ubiquitous, and found everywhere, not only upon the sick persons, but also upon the healthy ones, in the air, in the dust, in the soil, water, food, milk, clothing, houses, indoors and outdoors, and everywhere, so that it is difficult to find a place where they are not present; and (4) finally, the morbific agents are not found free in nature but are in close contact with various matter to which they cling and it is the most difficult task to separate them and free them from their surroundings.

Where, however, the presence of morbific agents is suspected or ascertained it is not very difficult to destroy them.

Viability of Bacteria.—Not all bacteria and morbific agents possess the same viability; there are certain con-

ditions, like mild heat, moisture, and nutrition, which are favorable to their growth and development, while other conditions, like too low or too high temperatures, dryness, absence of nutrition, and various physical and chemical agents, that are either inhibitive or destructive to the bacteria.

The **destructive point of most bacteria** differs according to the species, and this is also the case with the effects of heat upon them.

Some bacteria succumb to comparatively mild degrees of heat (as, for instance, the spirillum of cholera at 125° F. for four minutes), while others resist a boiling point a long time before being killed. This is especially the case with those bacteria which produce spores, notably the tetanus and anthrax bacilli.

The proper **means of destruction of pathogenic bacteria** will vary, therefore, according to the kind and species of microörganism, and also according to the medium in which it may be found, to the places where it may be lodged, and to many other factors.

A definition of the various terms used in the inhibition and destruction of pathogenic germs will be of benefit.

Disinfection is the absolute destruction of pathogenic germs, or the morbific agents.

A **disinfectant** is an agent capable of destroying pathogenic germs. A **germicide** means the same.

Sterilization is the absolute destruction of all organic life, whether infective or not; it is, therefore, more than disinfection which destroys the germs of infection only.

Antiseptics are agents capable of inhibiting pathogenic germs without totally destroying them; a disinfectant must be an antiseptic, but an antiseptic may not be a disinfectant.

Asepsis is the absence or exclusion of bacteria.

An **insecticide** is an agent capable of destroying insects; it is not necessarily a disinfectant, nor may a disinfectant be an insecticide.

A **deodorant** is a substance which neutralizes or destroys unpleasant odors; it is not a disinfectant.

Disinfectants are divided into three principal groups—physical, chemical, and gaseous.

Physical Disinfectants.—**Low temperatures** are not regarded as disinfectants, as they do not destroy bacteria, but only inhibit their action and growth.

Sunlight is a good disinfectant, provided the infective materials and the germs are directly exposed to the rays of the sun. The germ-destroying action of the light is thought to be due to the ultraviolet rays. Some germs are killed within a very short time of exposure to the direct rays of the sun. Tubercle bacilli are killed by direct sun rays within ten to twenty minutes of exposure, depending on the media in which they are located. Electric and other artificial light is said to have some germicidal action, but very slight in comparison to sun rays.

Desiccation is, like cold, an antiseptic, not a germicide, for, while bacteria must have moisture as a condition of their life and growth, desiccation will not always kill them; especially is this the case with the spore-bearing germs. *Koch* proved that the spore-bearing bacteria resist drying for indefinite periods. Non-spore-bearing bacteria lose their viability after complete drying.

Heat.—Of the physical disinfectants, heat is the most valuable, the most reliable, and the most commonly employed.

Heat may be applied as a disinfectant in several modes: By burning, baking, boiling, and steaming.

Burning is applicable only to such infected materials and objects which are so much infected as to make any other destruction of infective agents difficult or impossible, or it may be applied to infected materials which are of so little value as not to pay for the expense of any other method. It is not always easy to destroy certain infected materials by burning; at least, certain infected objects, like mattresses, etc., infected with cholera or typhoid excreta, may need very high degree of heat, possible only in special furnaces, for the total and absolute destruction of all germs, and unless the objects are totally consumed and turned to ashes, the process may not be regarded complete.

Dry Heat.—Some spore-bearing bacteria are able to withstand very high degrees of dry heat (140° C.). This method is applicable but to such objects as are not injured or destroyed by dry heat, such as metal and glass and like materials.

Boiling.—Most bacteria are killed at temperatures very much under the boiling point of water, while boiling for half an hour destroys most spore-bearing bacteria. Boiling is, therefore, a very valuable and efficient as well as inexpensive method of destruction of infective agents and materials, and is applicable to all objects which are not injured by the process, such as underwear, some kinds of clothing, textile fabrics, etc.

Steam.—This is the most valuable and efficient disinfecting method; steam kills all bacteria at once, while the most resisting spores are destroyed within a very short period; steam is also very penetrating and may be applied to a great many objects without injuring them. Steam may be applied in a small way for domestic disinfection: in convenient Koch and Arnold sterilizers, as well as in a large way for large objects in institutions and hospitals.

Steam may be used for disinfecting purposes in two forms—either as saturated, streaming steam, or as superheated steam under pressure. While streaming steam may be sufficient for certain objects and infected materials, the penetrating qualities of superheated steam used under pressure, and the fact that such steam leaves disinfected objects dry, make such form of steam disinfection more valuable and efficient.

Streaming steam is used in the disinfection of objects by the popular Arnold disinfector, as well as by the Koch apparatus. For disinfection by steam under pressure special apparatus, autoclaves, are used, which are made of wrought iron, or steel pots or kettles, cylindrical in form, lined with asbestos and provided with several chambers also supplied with means to produce a vacuum in the steam chamber.

Chemical Disinfectants.—Certain chemicals are capable of destroying pathogenic bacteria coming into contact with them.

The chemicals may be used in solid or liquid form or as gases. The disinfectant qualities depend on the character of the chemical constituents, the form in which they are used, and the material in which the infective agents and germs are lodged.

The objections against chemicals as disinfectants is that most of them must be used in very strong solutions, such as destroy not only the infective agents, but also the whole object to be disinfected; also the fact that chemical disinfectants must be thoroughly mixed with infected objects and come into direct contact with the infective germs, otherwise their action is not destructive. It is exceedingly difficult to disinfect properly certain infected objects like cholera and typhoid discharges unless the chemicals are very thoroughly mixed with every particle of the discharges, a mixture which is very difficult to obtain.

Carbolic Acid.—A good antiseptic, a comparatively weak germicide. Carbolic acid is not applicable to disinfection of material infected with spore-bearing bacteria, as its action upon spores is very feeble, and it has been recorded that some anthrax spores can withstand a forty days' immersion in a 5 per cent. solution of carbolic acid (*Rosenau*). Non-spore-bearing bacteria are killed in solution of carbolic acid from 3 to 5 per cent. Carbolic acid has little penetrating power. It is largely used in solutions from 2 to 5 per cent. for washing floors, walls, wooden surfaces, small objects, etc., and its range of usefulness is wide, because it is not injurious to most objects.

Cresols.—Of this group, the most commonly used as disinfectants are creoline, lysol, although others, like saprol, etc., may be employed. The cresols are more powerful disinfectants than carbolic acid, and are used for about the same objects.

Corrosive Sublimate.—The bichloride of mercury is a valuable disinfectant, and is used in solutions of from 1 to 2000 to 1 to 500. In the stronger solutions it kills germs rapidly, but because it unites and forms insoluble compounds with albuminous matter corrosive sublimate loses

much of its disinfecting property when used for infective agents mixed with much organic matter. According to *Rosenau*, corrosive sublimate kills spores in solution of 1 to 500 after exposure for one hour; solutions of 1 to 1000 destroy non-spore-bearing bacteria within a half-hour at ordinary temperatures. As an antiseptic, corrosive sublimate is used in medical and surgical practice in solutions of 1 to 2000 to 1 to 10,000.

Lime.—In the form of chlorinated lime, or of Labarraque's solution, it is a good disinfectant for excreta, and is used for disinfecting privy vaults, cesspools, cellars, etc. It is efficient only when it is used freshly prepared.

A number of other chemicals are used as disinfectants, although their range of usefulness is limited and they are not commonly so employed. Of these chemicals, mention may be made of potassium permanganate, ferrous sulphate, zinc chloride, copper sulphate, borax, boracic acid, and a number of others.

Gaseous Disinfectants.—Gaseous disinfectants are more valuable than other disinfectants because of their penetrating power and the possibility of reaching surfaces and places which are inaccessible to ordinary liquid chemicals. Of the gaseous disinfectants employed, the most important one is formaldehyde, which has lately superseded the once very popular sulphur dioxide disinfection. Of the other gaseous disinfectants sometimes used, are those of chlorine, bromine, and hydrocyanic acid, but these have been discarded almost entirely because of their very toxic nature and their questionable effects on bacteria.

Sulphur dioxide is a powerful germicide and a good surface disinfectant; the disadvantages of sulphur dioxide for disinfection are (1) that it is not very penetrating, (2) that it does not destroy spore-bearing bacteria, (3) that it damages textile fabrics, (4) that it bleaches vegetable colors, and (5) that it injures and tarnishes metals. It is also very poisonous to those handling it, causes injury to the mucous membranes of the eyes and nose and throat, and leaves a very disagreeable odor, clinging to materials for a very long time.

Several **methods of sulphur disinfection** are employed: The pot, candle, or liquid form, also by means of furnace. About five pounds of sulphur are to be used for every 1000 cubic feet of space to be disinfected. Moisture and heat increase the penetrating qualities of the gas and the value of disinfection. An exposure of twenty-four hours is necessary for thorough disinfection, and as the gas is very diffusible precautions must be taken effectively to close all windows, doors, and all cracks, crevices, and other apertures found in the room.

Sulphur disinfection is preferable wherever surface disinfection is needed and where there are few articles which would be deteriorated by it, also wherever insecticide action is demanded.

Formaldehyde gas has greatly superseded sulphur dioxide as a disinfectant. Its main value is that, while it is a good germicide, it does not destroy fabrics and injure objects as the latter, and also it is non-toxic. Formaldehyde is also but a surface disinfectant, its penetrating qualities not being very great. Bacteria are killed by formaldehyde immediately on direct exposure, and spores within an hour. It kills dried organisms as well as those in a moist state. Formaldehyde is not an insecticide. For domestic disinfection formaldehyde is generated by spraying liquid formalin (which contains 40 per cent. of the gas), or by heating paraform pastils or powder, also by means of generators or lamps. Other methods of evolving formaldehyde in disinfection which are used in large house and hospital disinfections are by means of large generators or lamps, or in specially constructed autoclaves under pressure, or in retorts without pressure.

Disinfection of Rooms, etc.—Practical disinfection is a process which needs scientific precision and attention to details. The disinfection must be adjusted to the form and nature of infection and the infected materials and objects, each of which may need a different method of handling and disinfection.

The disinfection of rooms and infected materials will

differ according to the disease; various methods may be needed to be employed after tuberculosis, typhoid fever, yellow fever, diphtheria, scarlet fever, etc.

The **room air** needs no disinfection, for whatever germs may be found in dust of the air in a room will settle upon the surfaces whenever the room is closed and left undisturbed.

The **room walls** if covered with paper may be efficiently disinfected by thorough rubbing with stale bread. Painted surfaces of walls and ceilings may be disinfected by washing with 3 per cent. solution of carbolic acid or a 1 to 500 solution of sublimate of mercury. Floors and other surfaces of rooms may also be conveniently scrubbed with hot water and a solution of carbolic acid or sublimate, or one of the cresols. Carpets, rugs, etc., may be efficiently disinfected by a strong solution of formalin, by gaseous disinfection with formaldehyde, or may be taken up and subjected to superheated steam under pressure. Curtains, hangings, etc., within the rooms are disinfected with formaldehyde, and may also be washed in boiling water. Wooden bedsteads may be washed with a 3 per cent. carbolic solution or a 5 per cent. formalin solution. Bedding, linen, etc., may be disinfected by steam, by formalin, and also by formaldehyde.

For the successful disinfection of rooms with a gas it is necessary to close all openings, cracks and crevices, keyholes, etc., completely, and especially the crevices about windows and doors. This is done by means of cotton, or, better, by means of gummed paper strips. Raising the temperature of the room assists disinfection. The room is then closed and all openings and crevices sealed with gummed paper, and the room is left for at least twenty-four hours.

Excreta, sputum, feces, and other discharges of infected persons must be gathered and collected in special glass or porcelain vessels and disinfected by means of the various chemical disinfectants like lime, cresols, carbolic acid, cresol, copper sulphate, and formalin. But whatever disinfectant is used, it must be thoroughly mixed with the dis-

charges so as to penetrate them through and through, and it must also be used in large quantities and very strong solutions.

QUESTIONS.

Define the following terms: constitutional, environmental, infectious diseases.
Define the following terms: exposure, invasion, infection, incubation, acme, crisis, lysis, relapse.
Define bacteria, bacilli, cocci, spirilla, and give examples of each.
Name diseases the morbific agents of which are known.
Name infectious diseases the morbific agents of which are unknown.
What action is produced by the morbific agent upon the body?
What are the common portals of entry of the morbific agents?
What are the modes of their transmission?
What are the agents of dissemination?
State in what way may domestic animals and insects become the source, the vehicles, and the intermediate hosts of infection
What are the roles of food, soil, air, and water in infection?
What are fomites, and what is their probable role in infection?
Define immunity, natural and acquired immunity.
Give examples of each.
Define the following terms: Toxins, phagocytes, alexins, agglutinins, opsonins, opsonic index, antitoxin.
How is artificial immunity produced?
Define active and passive immunity.
How is diphtheria antitoxin produced?
Name the social measures of the prophylaxis of infectious diseases.
Name the methods of destruction of morbific agents.
Name the physical disinfectants and their value as such.
Name the chemical disinfectants and their action.
Describe the action of the principal gaseous disinfectants.
How is formaldehyde generated and how used?
How are rooms to be disinfected?
What precautions are to be taken in room disinfection?
What are the various articles in rooms disinfected?
How are excreta and discharges from infected persons disinfected?

CHAPTER XI.

FEDERAL HYGIENE.

I. SANITARY LEGISLATION AND ADMINISTRATION.

The **functions of public hygiene** are the prevention of disease, conservation and promotion of public and national health.

The conservation of national health and the prevention of diseases cannot be accomplished without the coöperation of the public, of the general population, aided by the supervision and control of the public legislative representatives and executive officers.

Sanitary legislation is absolutely necessary for the purpose of public hygiene. It consists in laws, rules, and regulations for the removal of certain injurious influences, for the prevention of harmful action, for the supervision of public water, food, and milk supplies, for proper urban and rural sanitation, for prevention and control of infectious diseases, and for the numerous other functions intended for the conservation and promotion of national and public health.

Sanitary legislation must be followed by **sanitary administration,** for laws are but dead letters unless enforced by proper and competent authorities.

In continental countries sanitary legislation and administration are combined in a central sanitary administration, the duties of which are to supervise the execution of the national uniform sanitary laws and properly to administer them throughout the country.

In the United States sanitary legislation and administration are not uniform or centralized, but differ in various states and municipalities and bear a threefold character—federal, state, and municipal.

Federal sanitary legislation and **administration** are as yet very feebly developed in the United States, and is but limited to the census, quarantine, and to the "Food and Drug" act.

State sanitary administration differs in many individual states, some states possessing quite advanced sanitary laws, while others are wofully behind. The **state sanitary legislation,** when not issued for the guidance of local communities, consists mostly in creation of State Boards of Health, with advisory, rather than executive, powers, with some powers to examine and prevent certain nuisances, administer and supervise food and drug and milk laws, regulate the sanitation of water supplies, and prevent certain animal diseases, like tuberculosis, glanders, etc.

Municipal hygiene is the one branch of public hygiene which is the most highly developed, thanks to the advanced standing of some municipalities, especially those of the great centres of populations.

Municipal sanitary legislation, apart from the state public health laws, consists in the so-called "sanitary codes" of their sanitary authorities, while the administration is usually centred in the Health Departments, or Boards of Health, some of which are given, by the state legislatures and city charters, wide and summary powers.

Neither municipal legislation, as crystallized in the municipal codes, nor municipal administration, as exemplified in the Boards of Health, are uniform in each municipality, and hence there exists throughout the country a chaotic, non-uniform, and sometimes contradictory irregularity in sanitary administration and public health legislation.

National health being the greatest national asset, the prevention of national life waste and the conservation of national health becomes one of the most important national problems and duties, and there is no reason why the appalling infant mortality, the unnecessarily great death rate, and the loss of life by preventable diseases should not be a federal function, and not left to the politicians of various states and small hamlets and towns.

Extension and uniformity of the registration area through-

out the United States and the creation of a federal national department of health are the two objects at present agitated for by all advanced representatives of liberal thought and by all sanitarians.

The **legislative and administrative functions of the proposed Federal Department of Health** would include all or some of the following activities:

1. Uniform registration, vital statistics, and census.
2. Study and control of infant mortality.
3. Sanitary control of public education.
4. Sanitary control of industrial conditions, and especially female and child labor.
5. Urban and rural sanitation—research, study, and advisory control of state and municipal sanitary bodies.
6. Sanitary control of water, milk, and food supplies.
7. Quarantine, interstate and international.
8. Naval, military, and tropical hygiene.
9. Sanitary control of interstate commerce and transportation.
10. Sanitary information, research, study, statistics, and a system of popular sanitary education, through lectures, exhibitions, pamphlets, etc.

II. VITAL STATISTICS.

Definition.—Vital statistics is the collection and interpretation of the facts of the lives of populations.

Methods of Record.—The collection of facts and figures about the life of the people is accomplished (1) by the **census,** which is a periodical general enumeration of the population and a collection of detailed data about the life of the whole people of the nation, and (2) by the **system of registration** of certain civil data, such as births, marriages, and deaths, and diseases, which is a function of most municipalities, and is compulsory upon physicians, clergymen, etc., who become cognizant of those facts and upon whom lies the duty to report same.

The general census is made every ten years, while the system of registration is supposed to go on at all times.

The great value of the facts and figures gathered by both agencies is self-evident. Without such data no consideration of the condition of the populations is possible. Only by possessing reliable data of the life and condition of the population is it possible to judge of their economic, financial and sanitary standing, to compare the condition of one part or portion of the country and population with other parts and portions, to know the rate of mortality and morbidity, to give due warning of the increase of disease from one cause, or in one locality, and to find out the causes of the miseries of one part of the population as compared with the prosperities of another.

Registration records the births, the marriages, and the deaths, as well as the infectious diseases, the compulsory notification of which is a feature of almost all sanitary codes. Unfortunately the registration area comprises as yet but less than 50 per cent. of the area of the United States, and even in the registration area it is not uniform and complete in every place, so that data gathered by these means is not so valuable as it would be if there were a uniform and efficient system of registration throughout the whole country.

The **census,** which, until now, has been taken every decennial, gives the number of population, the races, nationalities, the number of native and foreign born, the number of sick and the nature of the disease, the deaths, births, and marriages during the census year, the sex, age, race, the density and overcrowding, the school, industrial, and commercial relations and conditions, the numbers of deaths and their causes, and a number of other sanitary, economic, and financial data.

In the collected data there are a number of errors, of commission and omission, and certain consideration is given to the probable errors in the interpretation of the data.

Of the many facts sought to be gained from the census and registration figures the most important are the following:

The actual and natural increase in population; the comparative number of persons of various races and nationalities; the birthrates, the marriage rates, the death rates, the morbidity rates, the duration of life, the expectation of life, etc.

The **actual increment of population** is the difference in the number of people counted by the census as compared with the census taken ten years before.

The **natural increment of population** is the excess of births over deaths.

Birth rate is calculated by the number of births in a year per 1000 population.

Marriage rates are also calculated by the number of marriages per 1000 population.

Morbidity rates are calculated only as to the infectious diseases the notification of which is compulsory, and rated by 100,000 population.

Death Rates.—The gross death rate is calculated in the same way as the births and marriage rates, as so many deaths per 1000 population, and is found out by dividing the number of all deaths by the number of the whole population and multiplying the result by 1000. In the explanation of the deaths the data given in the death certificates are of very great value. The data gives the nationality of the parents, the sex of the person, the age at which the person died, the character of house he died in, the urban or rural location of death, the race of the person, the disease which directly caused the death, and the disease which contributed to the death, as well as the occupation of the deceased. All these data are necessary for the proper interpretation of the figures and to the partial explanations of conditions bearing influence upon the death rates of populations.

Infant mortality rates are calculated not by the number of infants' deaths per 1000 population, but by the number of infants' (under one year) deaths to the number of births of that year.

"The **mean age at death** is the average age at which death occurs in that population, and is indicated by the total of the ages at death divided by the number of deaths."

The **probable duration of life** "is the age at which any number of children born will be reduced one-half, the chances thus being even that each will survive to that age."

Expectation of life "is the average number of years which an individual, at any given age, will continue to live, as shown by a life table."

III. QUARANTINE.

"Quarantine" **is defined** by Surgeon-General W. Wyman, as "the adoption of restrictive measures to prevent the introduction of diseases from one country or one locality into another." The term is derived from the French word **quarante**, *forty*, the number of days vessels were detained in the first Venetian quarantines.

The **necessity of quarantine** and of imposing some restriction upon the freedom of trade and commerce between nations and countries, especially during epidemics, has been referred to in the previous chapter.

The **modes of quarantine** may be international, national, state, and municipal, and each may impose certain restrictions on incoming people who arrive by railroad or ship, and who may be suffering from infectious diseases.

Quarantine regulations provide for the inspection of vessels arriving at ports, for the examination of the officers, crew, and passengers, for the detention of those already sick from infectious diseases and of suspected cases in detention camps, of disinfection of the cargo and baggage of the vessels, and destruction of rats, etc., in the holds of ships.

Quarantine regulations also prescribe the sanitation of the vessels, the cleanliness, ventilation, etc., and other such rules as would tend to the prevention of diseases in ships.

Clean bills of health are at present required from all incoming vessels, and are given by consular agents and authorities whose duty it is to inspect the vessels and examine its populations for cases of infectious disease.

As said before, quarantine may be exercised not only upon incoming vessels, but also upon railroads, etc.

IV. NAVAL HYGIENE.

The **function of naval hygiene** is the prevention of disease and preservation and promotion of the health of the inhabitants of seagoing vessels, whether they belong to the nation or to private owners.

The **problems of naval hygiene** may be divided into two parts—the care of the persons or seamen, and the sanitation of the ships.

The **sanitation of the ships** consists in the provision for proper space for the number of the crew and passengers, in the prevention of overcrowding, in the provision for the proper ventilation of the ships, the living and sleeping quarters of the crew and passengers, the lighting, the plumbing, wash houses, laundries, cooking, and other quarters, and especially the sleeping places of the crew, and the general provision about cleanliness and sanitary keeping of vessels, also their disinfection in cases of infection.

The **sanitary care of the crew** consists in the attention to all the objects of individual hygiene, in a proper and abundant as well as variable ration, in the provision for plenty of pure sweet water, in the examination of the crew for evidences of disease, in the insistence upon certain habits of cleanliness, etc., in the provision for treating of those who become ill, and in such other provisions as would tend to promote and preserve the health of the crew.

The prevention of tropical diseases (during sojourns in the tropics), the prevention of occupational diseases as relating to stokers and firemen, and the general prevention of all other diseases are also an important part of naval hygiene.

The crew of vessels, being entirely in the hands of the officers, even in commercial navy, there are certain laws prescribed by federal and other authorities to guard the interests and health of the men, so as to prevent injustice and inhumanity.

V. MILITARY HYGIENE.

The **function of military hygiene** is the prevention of diseases among soldiers and the preservation and promotion of their health.

Whether recruited by conscription, as in continental countries, or by voluntary service, as in the United States and England, the soldiers, once they are recruited, lose their independence and ability to care for their own health, and the care for their health, food, clothing, habitations, occupation, etc., entirely devolves upon their superiors; hence military hygiene, while dealing largely with matters in the province of personal hygiene, is a part of public hygiene either under state or federal control.

Selection of Recruits.—Only normal, robust, and healthy persons are chosen for soldiers, and as a weak or sickly individual may endanger the life of the entire body, great care is taken to reject any man with the slightest physiological defect.

Age.—Eighteen to forty-five years are the minimum and maximum ages of recruits, but the best age for recruits seems to be between twenty-one and thirty-five.

Height.—The minimum height is 5 feet 4 inches, the maximum is, for cavalry, 5 feet 10 inches, and for other branches according to weight. Very tall men do not seem to have the endurance and other qualities necessary for soldiers; the same may be said of men under 5 feet 2 inches in height.

Weight.—For cavalry service there is no minimum for weight, provided otherwise fit, while the maximum for cavalry is 165 pounds. Otherwise the minimum and maximum weights are 128 and 190, though sometimes exceptions are made in accepting otherwise fit recruits, weighing not less than 120 pounds. The physiological relation between height and weight is two pounds for every inch for persons 5 feet 7 inches tall, and 7 pounds for every additional inch above.

Chest Capacity.—This is a valuable index of the normal strength of the recruit. It is judged by measurement of circumference and by the extent of the chest mobility.

The measurements are made by tape-measure applied somewhat above the points of the shoulder-blades behind, and just below the nipple in front. The chest circumference is taken at extreme expiration and extreme inspiration; the difference between the two constitutes the chest **mobility**, which must not be less than two inches. The following table of chest proportion is official:

Height. Inches.	Weight. Pounds.	Chest at expiration. Inches.	Mobility. Inches.
64	128	32	2
65	130	32	2
66	132	32½	2
67	134	33	2
68	141	33¼	2½
69	148	33½	2½
70	155	34	2½
71	162	34½	2
72	169	34¾	3

The **grounds for rejection** are as follows: Defective development and non-conformity to age, height, weight, and chest capacity to above standards, defective vision, defective hearing, defective teeth, intermittent pulse, weakness and immobility of joints, sensitive testicles, varicose veins, flatfoot, inflamed bunions and hammer toe, and evidences of any diseases, constitutional.

Food.—The importance of proper food for the soldier has been aptly characterized in the famous saying, "An army travels on its belly." The food must be sufficient to support life, but must also be prepared so that there be variety, abundance, and tastefulness. The **rations** consist in "allowance for the sustenance for one person for one day, and consists of the meat, bread, vegetables, coffee, and sugar, the seasoning, and the soap and candle components." The ration varies somewhat in camp and for field or march (**emergency ration**).

There are a number and variety of so-called **concentrated rations**, in which it is sought to combine several foods in

a very concentrated form and in small volume, so as to easily carry several days' rations weighing comparatively very little; none of these rations, however, are capable of sustaining life for very long periods, and are used only for emergencies, forced marches, etc.

Water.—A soldier needs from 6 to 8 pints of water a day for drinking and cooking when marching, about 5 gallons a day while camping, and 10 gallons a day in permanent camps. This is exclusive of baths and sewage disposal needs; horses need from 6 to 10 gallons per day. The supply of pure water for the soldiers is one of the most important duties of the commissariat, and a previous thorough sanitary inspection of the sources of the water supply and a chemical examination of the supply is absolutely necessary. Wherever the water supply is at all suspicious it should be used only when boiled, or there should be carried with the commissariat wagons portable filters.

Sewerage and Disposal of Excreta.—The disposal of liquid and solid excreta of camps and barracks is of paramount importance, in view of the frequent raging of typhoid fever among soldiers and the difficulty of providing proper means of prevention of the contamination of the water supply.

Every temporary as well as permanent camp should be accompanied by a competent sanitary officer, who should take charge of the planning and executing of the proper provisions for the disposal of the urine and excreta of the soldiers, as well as of the proper disposal of other waste matters. Such sanitary provisions should be placed at some distance from the camp and in such location that it would not endanger the water supply. In temporary camps, iron pails or receptacles may be allowed to be placed at a distance from the camps, disinfected with proper solutions, and frequently emptied or cremated under the supervision of proper authorities. In permanent or semi-permanent camps a system of sewerage may be devised with plumbing pipes and fixtures, differing but little from an ordinary system of house plumbing. In view of the great importance of this subject in the prevention of disease

and preservation of health, the disposal of waste and excrementitious matter should be in charge not only of proper sanitary officers, but there must be instituted a system of sanitary police to insure compliance with the sanitary rules.

Clothing.—Much of the efficiency and the comfort of the soldier will depend on his clothing, its kind, material, weight, etc. The various articles of clothing—hats, underwear, trousers, coats, overcoats, shoes, etc.—must not only be strong and durable, but also light, well fitting, easily cleaned, proper for the climate, convenient, and of light weight and proper color. Underwear is best made of merino, or a mixture of wool and cotton, with an extra flannel or woollen shirt carried for extra wear. The use of two shirts, etc., is recommended in cold weather instead of increasing the weight of the shirts. Shoes are to be made of waterproof leather, with broad, thick soles, low heels, square at the toe, and not too heavy. Cloth caps are used in temperate climates, and should be loose fitting, light, durable, and comfortable.

The inspection of the clothing and its condition is one of the important duties of the officers.

Habitations.—The selection of the places for the temporary and permanent habitations, camps, barracks, quarters, etc., and the construction of these habitations is another important matter demanding expert sanitary knowledge on the part of the officers.

The selection of the site with a view to proximity of forest, marshes, watercourses and water supply, the preparation of the sites and foundations, the planning of the various buildings, and other matters regarding the construction of the whole camp cannot be gone into detail here, but are guided upon the general principles, some of which have been elucidated in the chapter on housing hygiene. The same applies to the question of proper ventilation, air space, lighting and heating of the barracks, etc. Barracks and squad rooms must not be too large, not over 24 feet wide and 14 feet high, and should provide at least 600 feet

floor space for every person. The care and cleanliness of the habitations, a matter of importance, should be the duty of the soldiers and under the supervision of their officers.

Individual Hygiene and Prevention of Disease.—The care of the soldier's health, all matters pertaining to individual hygiene, is of the utmost importance in the efficiency of the soldier in peace and war. The various rules guiding the life and habits of the soldier must be appropriate to the personnel, place, and climate, and must not only be supervised by the officers, but must be endeavored to be inculcated into the soldier's intelligence, so that by education he should understand the value of the different precautions for the preservation of his health and for the prevention of the various diseases to which soldiers are especially subjected.

QUESTIONS.

Describe the functions of federal, state, and municipal hygiene.

Name the functions of the proposed Federal Department of Health.

Define vital statistics. What are they based upon?

Define the following terms: registration area, actual increment and natural increment of population, birth rate, marriage rate, morbidity rate.

How are the mortality rates calculated?

What are "the mean age at death," "the probable duration of life," and "expectation of life"?

What is quarantine? At what times is it necessary?

What are the essentail points of quarantine regulations?

What are the functions of naval hygiene?

Describe the proper sanitation of ships.

State the rules for guarding the health of seamen

Give the principles of selection of military recruits.

State proper precautions in feeding soldiers in peace and in war.

Give rules for the water supply and drainage of camps, etc.

State points important in selection of soldier's clothing.

Give essential principles of selection of camps and habitations.

Give essential points of individual hygiene and prophylaxis.

CHAPTER XII.

SANITARY INSPECTION.

I. GENERAL INSPECTION.

Definition.—Sanitary inspection follows sanitary legislation and administration, for sanitary conditions must be surveyed, examined, and inspected in order to discover defects, to find nuisances, to detect violations of the public health laws, and to prevent disease by improving environmental conditions.

The **duty of sanitary inspection** is laid on the various municipal, state, or other sanitary authorities and health departments, who appoint and elect proper officers, whose duties it is to make the various examinations and inspections.

The selection of competent, expert, honest, and efficient **sanitary inspectors** is an important matter, unfortunately not everywhere as yet based on a proper civil service procedure, and not secured by proper compensation, secure tenure of office, and pension provisions.

The education of sanitary inspectors and officers is also not yet a part of the professional curriculum of schools and colleges, although sanitary inspection may well be termed a science as well as an art, the practice of which demands study and theoretical investigations and also practical knowledge and experience.

In the following pages an attempt will be made to give an epitome of some of the **subjects** and **objects of sanitary inspection** of various branches of public hygiene, without, however, going extensively into the question, or taking up any part of it demanding special knowledge of chemistry or bacteriology.

II. HOUSE INSPECTION.

Elements of House Inspection.—Sanitary inspection of houses, whether private dwellings, tenement houses, or any other buildings, consists in a thorough examination of the whole house, with the purpose of discovering (1) defects in construction, (2) defects in the condition of various parts of the house, (3) violations of laws, rules, and regulations imposed upon buildings of the character by various state or municipal authorities.

In order to be able to recognize defects and note violations of sanitary laws, the inspector must be thoroughly versed in the various sanitary laws of his part of the country, and must have a thorough and complete knowledge of building construction and house sanitation.

Details of House Inspection.—For a better review of house inspection methods the object of inspection must be subdivided into several broad groups. Thus the objects of house inspection may be classified under the following subdivisions:

1. House surroundings.
2. House construction.
3. House dampness.
4. Fireproof precautions.
5. Lighting.
6. Heating.
7. Ventilation.
8. Water supply.
9. Plumbing.
10. Care and cleanliness.

House Surroundings.—These are naturally the first objects of inspection. The surroundings of the house; the proximity of trees, rivers, lakes, ponds, etc.; the aspect of the house with relation to sun and wind; the configuration of the ground; the elevation above sea level; the relation of elevation to adjoining houses and plots; the presence of inclines, valleys, and hills in the immediate proximity; the nature,

height, and condition of surrounding houses; the nature, character, and materials of the walks, streets, and other spaces in the surrounding; the nature of the soil, its premeability, character, ground-water level, subjection to tides and inundations, etc. All the above points are proper and necessary subjects of careful investigation, inspection, and examination by the house inspector desiring to make a complete inspection and survey of a house.

Having inspected and noted the points of house surroundings, the inspector next has to examine the **site** of the building. The character of the site, its permeability, bearing capacity, dryness, freedom from contamination, and many other points must be examined for the effective understanding of many features of the house depending upon the site.

House Construction.—The inspection of houses during their construction is the duty of the bureaus of buildings, etc., which have their inspectors of masonry construction, inspectors of ironwork, inspectors of carpentry and joinery, etc., as it is difficult for one man to be expert in all branches of building. Such inspectors have charge of the corrections of architect's plans, the inspection and tests of the quality and strength of various building materials, and the character of workmanship in each of the various building branches.

The house inspector more often has to do with buildings already constructed, and his duty is to examine the condition of the various parts of the house construction, the condition of the frame or masonry walls, the strength of the beams, the condition of the walls, sidewalks, stairs, partitions, roof, eaves, leaders, doors, windows, and all the other numerous parts of the constructed house, to see whether they are all in proper condition, have not deteriorated since the construction so as to become a nuisance, and be detrimental to health and dangerous to life.

House Dampness.—The inspection of the damp-proof quality of a house is an important subject of house sanitation.

Knowing the causes of house dampness, the inspector will look for evidence of dampness in the house, in the walls, and in the cellar. As a rule, it is not difficult to judge damp

walls from dry ones, and the experience of the dwellers may at times be relied on so far as internal dampness is concerned.

The search of the causes of dampness must be directed to those causes which act upon the cellar and those which act on the walls. Defects in construction, newly built houses, absence of provisions for damp-proofing the walls, the condition of the roof, gutters, leaders, etc., are points to be carefully noted.

Dampness due to conditions in the cellar is still more important. When due to absence of provisions for isolation of footings, foundations, and walls from ground to entrance of underground water it is the most difficult to remedy the defects. The searching for the hidden causes of water in cellars presupposes a knowledge of the various sources as indicated in the chapter on Housing Hygiene.

Fireproofing.—The measures guarding the house against fire consist in the proper construction as well as in the provision for fire escape.

The points to be noted are the material of walls, floor, and ceiling, the character of floor joists, partitions, plastering, lathing, the presence of shafts, courts, and wells serving as chimneys for air currents, to protection of interior woodwork, especially near chimneys and fireplaces, the character of the roofing, openings from dumb-waiter shafts, etc., the construction and materials of stairways, the presence of enclosed spaces under stairways, etc. The construction, and condition of fire escapes is an important item of inspection in this respect. Whether constructed of iron or not, the kind and strength and thickness of the iron, the manner of fastening of the balconies to the walls by nuts and rivets, the balconies, rails, guards, standards, battens, size and character of balcony openings, the presence of gooseneck and drop-ladders, the construction of ladders, the angle of inclination, the size, thickness, and strength of the treads, the number of fire escapes, and a great many other minor points must be noted for a careful inspection of fire escapes.

Lighting.—The inspection of the natural and artificial modes of lighting consist in the following points: number

of rooms, number of windows in each, size of windows, location and character with regard to floor and ceilings; number of panes, character of glass, size and height of rooms, color of walls and ceilings, presence and size of light shafts and open courts, skylights and windows in halls and over stair wells, of rooms without openings into street or yard, width of street, yard, courts, etc.

The inspection of artificial source of illumination concentrates upon the following points: Whether central or local, gas, electricity, or oil, character of wire or pipe installation, quality and workmanship of installed service, tightness of pipes, presence of meters, quality of fixtures, character of tips, burners, and protection of nearby surfaces from fire, etc., number of fixtures, their height from floor, proximity to doors, walls, etc.

Heating.—When heating methods are but local, *i. e.*, when house is heated by grates or stoves, the inspection is comparatively of but little difficulty. More difficult is the inspection of a central heating plant.

The points of inspection are at first the adequacy of the heating system, its ability to raise the temperature of all the rooms to at least 70° F.

Various factors enter into the calculation of the necessary heating capacity of central plants and the pipes and radiators serving them. The cubic capacity of the rooms, the height and floor space, the character of the building (its material and construction), the exposure to wind and sun, the proximity of trees, etc., all the above enter as factors in the problem of adequately heating a house.

The inspection of the plant itself divides itself into the inspection of the furnace, of boiler, of pipes in the cellar, the inspection of the piping system and of the radiators.

The position of the furnace, the character of the cold-air box, the place where the cold-air box ends, the form of grate, the presence of evaporators, and of the control to prevent overheating the furnace are important points of inspection of hot-air furnaces. There are a number of important items of inspection of hot water and steam

boilers, their capacity, the water and steam gauges, the pressure and safety valves, the firing box, the grate, the connections, the protections of pipes in cellar by asbestos packing, the direction of pipes, the size of ascending risers and descending pipes, the form of expansion tank in hot water heating, the system and kind of steam-heating pipes used, the number of section of radiators, their proximity to windows, etc.

Ventilation.—The following are some of the points of inspection in the means and methods of ventilating houses.

The material and form of house construction; the floor space of rooms, their cubic capacity, the number and character of windows and other openings; the number of persons residing in each room; the character, size, bulk, and kind of furniture in the house; the system of heating and illumination, the presence of permanent openings into the external air, the temporary openings, the presence of chimney openings, grate fires and stoves, and the presence of mechanical means of ventilation.

The inspection of the mechanical ventilating plant consists in a thorough examination of the motor power and motors, the various fans, etc., the tightness of central and local ducts, inlets and outlets, the placing, size of inlets and outlets, the measure and control of the humidity of the air, velocity of air going through inlets, etc.

An examination, chemical and bacteriological, of the air in the room may be necessary to determine the impurities in the air, and their improvement. This will be described later.

Water Supply.—In cities with a central water-supply system the inspection of the water supply of a house consists simply in the examination of the material, size, and kind of main service pipe, presence of stopcocks and water meters, and an examination of the number, kind, material, location, and size of house service pipes and faucets.

In rural places, where a local supply is the source, the inspection of the sources and character of the water supply is a very difficult matter at times. Such an inspection

embraces the study of all the sources of water supply, the tracing of their sources, the examination of the ground, the precautions against contamination with sewage, the proximity to stables, vaults, and cesspools, the material and kind of receptacles, pipes, etc. It may be necessary to make a chemical and bacteriological examination of the water.

Plumbing.—The inspection of plumbing consists in the examination of the material, kind, and condition as well as workmanship of the fixtures and the piping which conducts the waste water into the street. The number, kind, and material of the sinks, laundry tubs, washbasins, bathtubs, and water closets, their condition and connection with the pipes; the forms, material, and kind of trap of those, as well as distance of the trap from the fixtures; the kind of connection of the traps and branch waste and soil pipes with the main soil and waste pipes; the manner and form of venting, or "back airing" of the traps; the material, size, form, and condition of the vertical soil, waste, vent, and leader pipes; the manner of their connection with the house drain; the material, size, kind, inclination, fall, and condition of the house drain; its connection joints, bends, and the number of openings on the house drain and the manner of their closing by covers or screw ferrules; the presence of main house trap, fresh-air inlet, and their condition; the material and condition and size of the outside leaders, gutters, and eaves. All the above are items to be carefully examined for defects.

Wherever plumbing pipes are exposed their inspection is ocular and presents little difficulty, although at times sand holes, small crevices, and puttied-up openings may be overlooked. Wherever the pipes are hidden the examination of the plumbing system must be supplemented by either the "peppermint" test or the "smoke" test.

The **peppermint test** is based upon the fact that any pungent volatile substance will escape from defects in pipes provided all other openings are closed. The method of applying the peppermint test is as follows: Several ounces

of peppermint oil (some other pungent substance may be used) are poured into some opening in the pipe system, preferably into the opening of one of the pipes on the roof. The opening of the pipe into which the oil had been put, as well as all other openings on the roof, are then closed with waste paper or plugs, and the oil allowed to be distributed through the pipes. The main house drain being closed to the escape of the smell by the main house trap, the odor is held within the pipes and will escape from any slight crevice, hole, or opening. The pungency of the oil is intensified by the addition at the same time of hot water. None of the fixtures are to be used during test, in order that the peppermint may not escape from them.

The smoke test is said to be a more thorough test for the pipes. It is applied by smoke being introduced into the pipe system after the opening of vertical pipes are closed with plugs. Special smoke producing bombs, rackets, and appliances are sold by dealers for the test.

Cleanliness.—The cleanliness and condition of any and all parts of the house is inspected by going through all parts and corners of the house and seeking for refuse and dirt.

The following inspection card of the New York Tenement House Department shows an example of an official examination:

STREET ....NO.......... ........WARD..................DIST............ .... DATE ....

IGHT

Over Stairwell IN ROOF: Area glazed surf.-Size of X Opening-Ridg. Vent.-Louvres; Obstructed
Dome light under ADEQUATE

BULKHEAD: Area glazed surf.-Windows: Number Size How open Other ventilation
ADEQUATE

WINDOWS IN HALL: Number Size

How hung Location VENT. ADEQUA

TLE-BULKHEAD
32 SCUTTLE: Size X opening Outside: Metal cov.-Wood-Iron-Glazed Lock Needs hinging BULKHEAD: Door top of stairs-Lo
Door foot of stairs-Lock

DER-STAIRS: Stationary-Wood-Iron-Handrail Short Accessible ADEQUATE

Length	Width	Area	Materal of Walls	Starts at	Covered	Vent. Skylight	Suff. access at base 106	By Door	By Window: Size Open'g	By Window: Sill above floor of Room	By Window: Sill above floor of Shaft	By Window: How hung	By Window: Ladder needed

FIRE ESCAPES
29-30 One each apt. LOCATION: Fro
Rear-Sh

Party wall balcony; Wall pierced where
ADEQUA

Where lacking

Egress from Yard

BALCONIES: Wood-Iron-None RAILINGS
Wood-Ir

WINDOWS	J	K	L	M	N	O	P	Q	R	S	T
Width											
Height											
Dist. below ceil.											
How hung											

FLOORS: Wood-Iron STAIRS: Wood-Iron-Open trea
Solid tre

LADDERS: Vert.-Inclined-Double rung-Hand rail-Missing what
floors-Drop ladder needed

YARD FIXTURES
100 School sink-Latrine-Privy vault-Water closets; Number Compart.
(Sewer in street)

CLOSET ACCOM.
100 No. in Yard-Cellar-Apts.-Stores-Total Used by Families: In Bldg.-
Other Bldgs.-Stores-Total

REMARKS Ratio: 1. W. C. to families

FIXTURES	Number per Floor: Cellar	Base	1	2	3	4	5	6
SINKS IN HALLS								
Wood encased 99								
WATER CLOSETS In Halls (Pan.)								
In Apts. (Pan.)								
Wood Risers 98								

III. HOUSE INSPECTION CHART.

1. General.

Street.	Number.	Date.
Stories.	Floors.	Apartments.
Owner.	Agent.	Address.
Number families.	No. under 16 yrs.	No. under 1 year.
Population.	Male.	Female.
Deaths last year.	Diseases.	Accidents.
Average rent apartm't.	Room.	Total.
Living apartments.	Stores.	Shops.

2. Surroundings.

River.	Swamps.	Marshes.
Forest.	Trees.	Fields.
Factories.	Saloons.	Railroads.

3. Plan.

Attached.	Semi-attached.	Detached.
Feet front.	Feet wide.	Long.
Size lot.	Square feet built.	Empty space.
Elevation.	Ground-water level.	
Plan floors.	Plan apartments.	Plan rooms.
Height of building.	Width street.	Depth yard.

4. Site.

Kind of soil.	Character.	Moisture.
Aspect of front.	Of rear of house.	Of bedrooms.
Foundation material.	Footings.	Dry areas.

6. Construction.

Material.	Facing.	Internal walls.
Depth of walls.	No. windows front.	Rear.

Material partitions.	Stairs.	Floors.
Width of entrance.	Halls.	Stairs.
Material of roof.	Fire escapes.	Scuttles.
Windows in halls.	Number.	Size.

7. Cellar.

Size.	Height.	Width.
Windows.	Openings.	Doors.
Walls.	Floors.	Bins.
Occupation.	Separation from house.	
Conditions.	Defects.	Light by day.
Light by night.	Ventilation.	Cleanliness.

8. Roof, etc.

Material.	Pitch.	Condition.
Skylight.	Scuttle.	Bulkhead.
Ladder stairs.	Doors.	Windows.

9. Fire Escapes.

Number.	Kind.	Material.
Balconies.	Floors.	Openings.
Rails.	Standards.	Sizes.
Ladders.	Inclination.	Angle.
Hand rail.	Drop ladder.	Goose neck.
Stairs.	Tread.	Sizes.

10. Lighting.

No. windows in house.	In apartment.	In room.
Window area.	Location.	Size.
Open street.	Yard.	Court.
How hung.	Height.	Width.
Distance below ceiling.	Above floor.	Width of piers.
Artificial light, kind.	Source.	Quality.

Material; service.	Number fixtures.	Number lights.
Make test of gas service.	Condition.	Meters.

11. Ventilation and Heating.

Air space per person.	Floor space per person.	Methods of natural ventilation.
Local or central?	Kind.	Efficiency.
Condition.	Defects.	Any special provision for ventilation?

12. Water Supply.

Source.	Kind.	Quality.
Material of pipes.	Tank.	Fixtures.

13. Condition.

Sidewalk.	Front area.	Frontage.
Halls.	Yard.	Drainage.
Paving.	Grading.	Rear area.
Rear of house.	Fire escapes.	Encumbrances.
Hall ventilation.	Stairwell.	Stairs.
Roof.	Skylight.	Scuttles.
Apartments.	Rooms.	Janitor.

14. Plumbing.

Fixtures.	Number.	Material.
Location.	Connection.	Sizes.
Water supply.	Faucets.	Condition.
Pipes.	Sizes.	Material.
Joints.	Pitch.	Support.
Location.	Extension.	Caliber.
House drain.	Location.	Position.
Support.	Pitch.	Joints.
Bends.	Handholes.	Covers.
Air inlet.	Size.	End.

Traps.	Kinds.	Sizes.
Material.	Shape.	Number.
Location.	Distance from fixtures.	Screw caps.
Main trap.	Location.	Size.
Vent pipes.	Branches.	Connection.
Sizes.	Material.	Location.
Area drains.	Eaves gutter.	Leader.

15. Plumbing Tests.

Air pressure.	Water.	Smoke.
Peppermint.		

Note.—The blanks for house and other inspections are neither official, nor complete and perfect. They are simply suggestions based upon long practical experience, and may be greatly improved upon.

IV. HOUSE INSPECTION, SPECIAL.

House Dampness.

Signs.—Musty, mouldy odor.
Wall spots and discoloration.
Dry rot (destruction of timber by fungus).
Efflorescence of masonry.
Effects on objects: Iron rusts; salt, etc., deliquesces; shoes, etc., mildew; quicklimes slake.
Fungi, mould develop.
Relative humidity of room increases.

Test for Amount of Moisture in Walls.—Remove with trowel from several places in the wall 10 grams of mortar and put same in hermetically closed bottle. The mortar in the bottle is then weighed (with deduction for the bottle) and the sample of mortar is then dried by a blast of hot air (100° C.) which has been previously freed from its moisture

and CO_2 by lime and sulphuric acid. After drying for one hour the samples of mortar are weighed, the difference in weight between the dried and crude state being the amount of moisture in sample and wall.

Tracing Sources of Water in Cellars.

Examine topography of site, character of soil, ground-water level, and material of foundation and footings.

Quantity of water.

Constancy of the water, temporary or permanent.

Level of the water

Point of entrance.

Depth of point of entrance.

Mode of entrance.

Physical examination: color, clearness, taste, odor.

Chemical examination: nitrites, nitrates, ammonia.

Color test with uranine, fuchsine, etc. Put coloring matter into fixture suspected and watch for appearance of color in the cellar water.

Examination of Air in Rooms.

The **qualitative and quantitative determination of impurities in the air of rooms** is a very difficult process, as there is no method as yet discovered to find out the character and amount of the various organic emanations from the human body which make the air in inhabited rooms so much more poisonous than air simply supercharged with CO_2 or other gases. According to some investigators the increased temperature of inhabited rooms plays a very important role in the air deterioration. However, as the amount of CO_2 in the air of inhabited rooms seems to increase in the proportion of the vitiation of the air by the general organic emanations of persons present, the amount of CO_2 has been hitherto regarded as a standard for the amount of air deterioration. There are a number of ingenious tests for the determination of the amount of CO_2 in the air, most of them being quite

complicated and requiring a complex process of chemical analysis and calculations. The following are the essential points of the standard tests:

Pettenkoffer's Test.—Barium hydrate mixed with carbonic acid produces, besides water, an insoluble salt—barium carbonate. If we then mix a known amount of barium hydrate in solution with a known amount of air, part of the barium hydrate will go to form the barium carbonate with the carbonic acid in the air and part will be left undissolved. We can then calculate the difference in the amount of the barium hydrate in the solution before its mixture with the air and after, which difference will indicate the amount of carbonic acid in the examined air. The amount of barium hydrate is determined by a standard solution of oxalic acid. The tests must be made at a temperature of 32° F. and barometric pressure from thirty inches of mercury, or corrections must be made as to this temperature and barometric pressure. The test is very complicated and requires special apparatus and great skill.

Wolpert's Test.—In this test a solution of carbonate of soda colored red by phenolphthalein is used to mix with a given volume of air to be examined. When mixed with the examined air part of the carbonate of soda unites with the carbonic acid and forms bicarbonate of soda, thus lessening the alkalinity and also the red color of the solution. The more carbonic acid in the examined air the quicker the disappearance of the red color. The apparatus is furnished with a scale so that the approximate amount of carbonic acid is determined.

Angus Smith's Test.—Lime water when mixed with carbonic acid gets cloudy and precipitates. Six bottles of a capacity, respectively, of 150, 200, 250, 300, 350, and 450 c.c. are stoppered with rubber caps, and into each bottle 15 c.c. of fresh lime water is put. The bottles are then filled with the air of the room and the smallest bottle which shows a precipitate is noted. The amount of CO_2 which is present in the air of the bottles when they get cloudy is—in the sized bottles enumerated above—as follows: 1.6, 1.2, 1,

0.8, 0.7, and 0.5 per 1000, so that if the smallest bottle gets a precipitate on mixing of the lime water in the flask with the air of the room the amount of CO_2 is 0.16 per 10,000, or about four times the normal amount.

Relative Humidity.

The relative humidity of the air of rooms may be tested by means of various instruments called hygrometers, psychrometers, etc.

The **easiest method of determining relative humidity** is by means of the wet and dry thermometers, in an instrument called the hygrodeik. The instrument consists of two thermometers attached to a chart, one thermometer being dry, while the other is kept wet by means of a cotton wick immersed in a glass water-filled vessel. The calculation of the relative humidity of air is made on the difference in the temperature shown by the dry and wet thermometers, and the ready chart makes it easy by simple manipulation to find out in a moment not only the relative humidity, but also the amount of moisture in grains per cubic foot of air.

V. SCHOOL INSPECTION.

School inspection is either sanitary or medical.

The **sanitary inspection of schools** embraces examination of the site, construction, and condition of the building itself, and does not materially differ from general housing inspection, as indicated in the previous schedule, except, perhaps, that more attention is to be paid to ventilation and heating than in common houses.

The inspection of the school utensils, desks, seats, etc., is not, as a rule, in the hands of sanitary inspectors, but belongs to the school superintendents, etc.

The **medical inspection of the pupils** is a part of the duty of school inspectors appointed, as a rule, by the Health Departments.

The following **blank for physical examination of pupils** is used by the New York Health Department:

DEPARTMENT OF HEALTH, CITY OF NEW YORK.

Physical record of sex born
nationality of father mother

Number in family adult child. Number of births measles scarlet diphtheria pertussis pneumonia la grippe

Date of examination School

1. School year.
2. Term.
3. Class.
4. Revaccinations.
5. Diseases during term.
6. Date of physical examination.
7. Height.
8. Weight.
9. Nutrition.
10. Anemia.
11. Enlarged glands.
12. Nervous diseases.
13. Cardiac diseases.
14. Pulmonary disease.
15. Skin diseases.
16. Defects orthopedic.
17. Defects of vision.
18. Defect of hearing.
19. Defect of nasal breathing.
20. Defect of palate.
21. Defect of teeth.
22. Hypertrophied tonsils.
23. Adenoids.
24. Mentality.
25. Conduct.
26. Effort.
27. Proficiency.
28. Treatment.

VI. FACTORY INSPECTION.

A complete sanitary inspection of a factory or industrial establishment must embrace a thorough inspection of the following items: (1) The factory building; (2) The workers, census, age, sex, etc. (3) The processes of work—industry, manner, dust, etc. (4) Protection against accidents, etc.

The **following factory inspection blank** is an attempt to cover most of the points of interest to the sanitary inspector.

Report of Inspection of Factory.

Street and number
Date of inspection
Name of owners, lessees, agents, etc.
Address of owners, lessees, agents, etc.
Number of stories   floors   material of building
Character of work   materials   goods made

Employees.

Total number   females   children under sixteen
boys under sixteen   girls under sixteen   illiterate
Regular weekly hours of children under sixteen   of females under twenty-one   all employees
Night work   Do women work at night?
Overtime   Is record kept?

Meal Time.

Time for noonday meal   lunch

Wages.

How paid?

Elevators.

How many? Are cables, etc., guarded and safe?
How is well hole protected? How elevator entrance?
Age of employee running elevator.
Number of hoistways Are they enclosed?

Machinery.

Are males under eighteen or women under twenty-one permitted to clean same?

Are children under sixteen allowed to work on dangerous machinery?

Belt shifters in use? Any machinery specially dangerous?

Are belting, gearing, flywheels, set screws, vats, etc., guarded?

Any dust-creating machines in operation?

Any emery wheels in use? Who is working them?

Any children or women? Are there exhaust fans?

Are they properly constructed? Are they in operation?

Are they effective? Is there much dust in shop?

Boilers.

Number in use kind when inspected?
Have they steam, water gauges, and safety valves?
Any accidents reported?

Building.

Material.	Safety.	Floors.
Walls.	Ceilings.	Doors.
Roof.	Skylight.	Scuttles.
Stairs.	Number.	Material.
Width.	Hand-rails?	Screened?

Fire Escapes.

Number.	Material.	Sizes.
Balconies, size.	Opening.	Rails.
Ladders.	Incline.	Rungs.
Handrails.	Screened.	Obstructions.

Lighting.

Windows.	Number.	Location.
Sizes.	Glass.	Is light sufficient?
Artificial illumination.		Kind.
Is it dependent on motive power?		Service.
Nearness to workers.		Kind of burners.

Heating.

Kind.	Efficiency.	Temperature.
Humidity.	Care.	Condition.

Ventilation.

Air space total for each worker.		Floor space.
Natural.	Artificial.	Mechanical.
Quality of air in shop.		Amount of CO_2.

Wash Rooms, etc.

How many?	Separate for male and female?	
Kind.	Efficiency?	Hot water?
Dressing rooms?	Many?	Separate?
Seats for females provided?		Lunch rooms?

PLUMBING.

Number of washbasins?		Number of water closets?
Kind.	Character.	How flushed?
Clean?	Separate for males and females?	
Any dwarf partitions?		Condition of water closets.
Traps.	Number.	Kind.
Soil.	Waste.	Vents.
Extension.	Ventilation.	Fresh-air inlet?
House drain.	Size.	Hand-holes.
Condition of plumbing.		Test made?

DANGERS.

Any gases or fumes?	From what?
How produced?	Any complaints?
Effects on workers.	Any sickness?
Any poisonous material?	Nature.
Dangers.	How prevented?

ACCIDENTS.

Have any accidents whatever occurred during the year?

Nature.		Extent.
Disability.	Permanent?	Temporary?
Total?	Partial.	Recovery?
Causes.	Defects?	Have they been remedied?

Date of previous inspection

Inspected by

Inspector.

VII. WATER INSPECTION.

An examination of the quality and purity of water for drinking purposes is a very complicated procedure, requiring not only expert sanitary knowledge, but also a thorough training in chemical and bacterial analysis, and a capacity for weighing and comparing all data gained in order to base judgment on them.

A **microscopic and bacteriological examination of drinking water** by itself is of little value, as a water may be very much polluted with organic matter without necessarily showing the presence of any pathogenic bacteria; nor is the failure of finding any pathogenic bacteria in a sample of a given water a proof that such water is not contaminated with germs of typhoid, or cholera, etc. A bacteriological examination is, therefore, valuable only when positive results are obtained, and in conjunction as an aid to a sanitary and chemical examination.

Nor is a **chemical examination of a water** sufficient by itself to give sufficient data for basing a judgment on the quality of the water, for a water may contain chlorine, nitrates and nitrites, and ammonia, and still not be very bad; and the presence of one or more chemical ingredients may be due to so many different causes that a qualitative opinion may not be possible to be based upon these data alone.

A **sanitary inspection of the sources of a given water,** of the surroundings and mode of formation of the water collection, is comparatively of more importance than any other examination; and a chemical examination of a water must be made after a thorough sanitary inspection of the water supply, and then only would be valuable as a procedure for the judging of the purity and quality of the water.

The sanitary inspection of the sources of the water supply consists in an examination of the place where the water comes from, the place where it is collected and stored, and the possible sources of organic contamination in the immediate neighborhood of the water.

The **sanitary inspection of rivers, lakes, and ponds** will then consist in the examination of the sources of those watercourses, the condition of the shores, the presence of habitations, factories, and other settlements upon the shores, and their polluting the water by their waste matters and sewage; the presence of considerable number of cattle drinking from the watercourses; the manner of conducting the water from those places to the habitations, and many other similar important subjects.

The **sanitary inspection of rainwater** supplies will limit itself to an examination of the storage and collection surfaces and vessels, their covers, and the time the water is stored.

The **sanitary inspection of wells** consists in the examination of the probable sources of the water within the wells, their depth, shallow or deep, the proximity of stables, manure pits, cesspools, privies, etc., to the wells, and the possibility of pollution of the well water by their drainage; the proximity of cattle pens, hog pens, and other animal habitations; the form and depth of the well as well as the depth of the water therein; the method of covering the walls of the well, also the mode by which the water is drawn from the well, etc.

While it is possible by the sanitary inspection of the sources of the water supply to judge of its possible purity or contamination, a positive proof of pollution may be gained only by a chemical examination.

Besides a **physical examination** of the color, turbidity, reaction, odor, and total amount of solids in the water, we find by a **chemical examination** the degree of hardness, the amounts of chlorine, ammonia, nitrates, nitrites, other compounds, gases, and acids, as well as the presence of metals.

In **collecting samples of the water** for chemical examination care must be taken to use clean bottles and to perform the examination as soon after the collection of the samples as possible. Glass bottles containing half a gallon are commonly employed for taking samples, and the bottles

are rinsed and washed in the water to be examined and closed by glass stoppers.

The **color of the water** is judged from its appearance by putting it into an 18- or 24-inch glass tube and comparing the sample with a similar tube filled with distilled water. Good waters are either bluish or grayish. Green, brown, or yellow waters are suspicious.

The **turbidity of the water** may be examined in the same way, and a standard of turbidity is indicated by the impossibility to read printed matter through the water-filled glass tube.

The **odor of the water** is more perceptible when the water is heated.

The **total amount of solids** is determined by evaporation and weighing of the residue.

The many qualitative and quantitative tests of various ingredients require expert chemical knowledge and experience for understanding, and cannot be gone into here.

The **significance of the various ingredients** in an examined water is a matter of expert consideration, and depends on the quantities of the ingredients and on other factors. The following brief remarks may be of benefit:

Chlorine.—Sewage contamination is always followed by presence of chlorine in chlorides, although chlorine may be contained in water which is not contaminated by sewage, but may be due to deposits of salts, or to sea water. A marked presence of chlorine, however, should be regarded as suspicious of sewage.

The presence of considerable amounts of **free ammonia,** as well as **albuminoid ammonia** point to the conclusion that the water is contaminated by organic matter, sewage, or urine.

Nitrites and Nitrates.—Organic matter contains nitrogenous compounds, which upon undergoing chemical changes and oxidation produce nitric and nitrous acids. The presence of the latter, therefore, indicates contamination with organic matter. Pure water is free from nitrites and should contain

very presence of nitrites is suspicious, while the amount of nitrates must be marked before the water may be classed as suspicious. **Nitrates** are generally due to oxidation of organic matter of animal origin. **Nitrites** are due to sewage contamination. They indicate more recent contamination, and are more dangerous.

Metals.—Except for traces of iron which any good water may show, no metal should be found in water.

As a rule, not without its exceptions, a water which is contaminated but recently with sewage matter will, upon chemical examination, show a marked presence of chlorine, ammonia, *nitrates*, and *nitrites*. In order, however, to judge scientifically it will be necessary to make thorough qualitative as well as quantitative tests, in conjunction with a sanitary inspection of the water supply, as well as bacteriological tests.

VIII. FOOD INSPECTION.

The inspection of meat and fish foods, the characteristics of good and bad meats and fish foods, have already been alluded to in the chapter on Food Supply.

In general, the inspection of most foods for condition, adulteration, preservatives, bacterial and other contaminations requires a thorough chemical and bacteriological analysis, into the details of which we cannot go here.

Condiments, beverages, flours, bread, cereals, and prepared foods must be examined chemically to detect deleterious substances, except when some physical characteristic, like appearance or odor or the taste of the food, mark them as unfit for food.

Canned foods, or foods in hermetically sealed tins, must be rejected when their tops or bottoms bulge out, which shows that some decomposition with formation of gases is going on within.

Fruit and vegetables when in raw state may be judged by their color, appearance, odor, and taste. Under-ripe,

green fruit may become harmful; over-ripe and partly decomposed fruit and vegetables are very often indicated by the decomposed appearance of the skin and top layers.

The presence of injurious coloring, or preservative ingredients cannot be detected with a chemical examination.

IX. SANITARY INSPECTION OF THE PRODUCTION OF MILK.

(Department of Dairy Industry, New York State College of Agriculture.)

Dairyman Date
Location Postoffice
No cows in herd milking quarts milk cans or bottles
Milk sold to License No.
Report by at milking time. Hour

I. Health of the Herd and its Protection.

Do all cows appear healthy?
Are udders sound and free from signs of disease?
Are cows tuberculin tested?
Date of last test. By whom?
Is stable well built to protect from weather?
Are cows brought in during bad storms?
How many hours are cows out daily?
Width of stall Length
Is stall comfortable? How are the cows tied?
Kind and quality of bedding
Where are cows kept when sick and at calving time?
Is the stable well located?
Number and size of windows
Size of stable length width height
How ventilated?
Kinds of feed used

Are they of good quality and proportions?
Source of water for cows
Method of watering

II. Cleanliness of Cows and Their Surroundings.

Are the cows clean? How are they cleaned?
Is the hair clipped about the udder?
Is the udder cleaned before milking? How? When?
Is the stable free from accumulations of cowbebs, dirt, and dust?
Is the stable whitewashed?
Any other animals in stable? Kind Number
Same, adjacent rooms What openings between?
How far is privy from stable? Any chance of contamination?
How often is manure removed from stable?
Where to?
Is the barnyard free from manure, refuse, stagnant water, etc.?
Is the pasture clean and free from injurious plants and mud holes?
Is the stable provided with dust-proof ceilings and partitions?
Is feeding done before or after milking?
Is the floor swept or dampened before milking?
Is the air free from dust and odors?

III. Construction and Care of Utensils.

Are all utensils, such as can be, thoroughly cleaned?
Method of washing utensils? How sterilized?
Is the water used for washing pure? How do you know?
What is its source?
Is the source protected from contamination? How?
How are utensils cared for after cleaning?
Is a small-top pail used? What style and size of opening?

IV. Health of Employees and Manner of Milking.

Any contagious diseases in family or among employees?
Are the milkers clean personally?
Do the milkers wear special clean overalls?
How often are these washed?
Do the milkers wash their hands before milking?
Where? How?
Do the milkers have wet hands during milking?
Are the milkers careful not to dislodge hair and dirt from the cow while milking?
Is the foremilk discarded? Where?

V. Handling of Milk.

How is the milk cooled?
How soon after milking is the milk cooled?
To what temperature?
Is the milk handled in a room detached from stable?
What kind of floor?
Is the milk room used exclusively for milk?
Is it clean and free from dirt and odors?
At what temperature is milk kept after cooling?
How is milk cared for during transportation?

SCORE CARD FOR THE PRODUCTION OF SANITARY MILK.

Date Dairy of P.O.

		Perfect	Score
I. Health of the herd and its protection.	Health and comfort of the cows and their isolation when sick or at calving time	45	
	Location, lighting, and ventilation of the stable	35	
	Food and water	20	
	Total	100	
II. Cleanliness of the cows and their surroundings.	Cows	30	
	Stable	20	
	Barnyard and pasture	20	
	Stable air—freedom from dust and odors	30	
	Total	100	
III. Construction and care of utensils.	Construction, cleaning and sterilization of utensils	40	
	Water supply for cleaning, location and protection of its source	25	
	Care of utensils after cleaning	20	
	Use of small-top milking pail	15	
	Total	100	
IV. Health of employees and manner of milking.	Health of employees	45	
	Clean overall suits and milking with clean dry hands	30	
	Quiet milking, attention to cleanliness of udder and discarding of foremilk	25	
	Total	100	
V. Handling of milk.	Prompt and efficient cooling	35	
	Handling milk in a sanitary room and holding it at low temperature	35	
	Protection during transportation	30	
	Total	100	
	Total all scores	500	

If the total of all scores is	And each division is	The sanitary conditions are
480 or above	90 or above	Excellent
450 or above	80 or above	Good
400 or above	60 or above	Medium
Below 400	Below 60	Poor

The Sanitary conditions of this dairy are

Scored by

Inspector.

QUESTIONS.

What are the most important points to which attention must be paid in inspecting a house?
How is the plumbing of houses inspected?
What are the tests for defective plumbing?
What are the tests for house dampness?
How would you trace the sources of water in cellars?
How is the relative humidity of a room tested?
What are the principles of testing air for CO_2?
Give principal items in medical school inspection.
Give most important points in factory inspection.
What is determined by a physical, chemical, and microscopic examination of water?
What are the principal points in a sanitary inspection of the sources of water supply?
What precautions must be taken in taking samples for water inspection?
What is the relative significance of the presence of nitrites and nitrates in water?
What would be a clear indication that canned goods are unfit for food?
What are the main points of dairy farm inspection?
What is a score card as relating to dairy inspection?

INDEX.

T